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STRUCTURAL ENGINEERS • PLANNERS • DESIGNERS



July 11, 2011

**Nashua Miliard Chimney Seismic
Analysis**
**Prepared for: The City of Nashua,
New Hampshire**

Nashua – Millyard Chimney Lateral Analysis July 11, 2011

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July 19, 2011

Mr. Leon Kenison, P.E.
Broad Street Parkway, Administrator
9 Riverside Street
Nashua, NH 03062

RE: Nashua Millyard Chimney Lateral Analysis

Dear Mr. Kenison,

At the request of the City of Nashua, Weidlinger Associates, Inc. (WAI) has undertaken a lateral analysis of the Millyard Chimney located at 10 Technology Way, Nashua, New Hampshire. The square, 180foot high, unreinforced brick masonry (URM) chimney was built in the 1880's. Our analysis includes wind loads both perpendicular and at 45 degrees to the chimney face at the original chimney height 180ft and at a reduced height of 100ft. The seismic analysis includes a load case perpendicular to the face at the chimney full height and at 45 degrees to the face assuming the chimney is reduced to the height of 100 ft.

We considered the brick to be sound, but the mortar to be in an unacceptable condition requiring major repairs. When analyzing URM structures under seismic conditions, tension in the mortar is not permitted, and given the mortar condition WAI also used this criterion for the wind analysis. It turned out that this criterion governed the results of our analysis.

Findings:

1. WAI found that at the original height of the Chimney, it did not meet the current day design requirements for either Wind loads or Seismic loads.
2. At the reduced height of 100 ft. the chimney can sustain code mandated wind loads with a ground velocity of 93 mph from any direction. At this 100 ft. elevation, the chimney only meets about 33% of the seismic design load requirements.

Recommendations:

1. At the WAI recommended chimney height of 100ft, we believe that it is reasonable to ask for a variance to meet reduced seismic loads.
2. For the mortar to be minimally acceptable, the quality of the inner wythe mortar joints needs to be review, and if they pass, then the chimney liner must be removed and both the interior and exterior faces would have to be 100% repointed. After repointing, testing or retesting the brick mortar axial and shear capacity is allowed.

Millyard Chimney Analysis
Executive Summary

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3. With the chimney at its full 180 height, it is difficult to seismically upgrade it with an interior steel structure. At 100 ft. high, it may be feasible to construct a steel reinforcing system inside the chimney. Given the mortar condition, through bolting the brick to the steel might require the use of brick stars. Brick stars are cast iron plates, often with a star profile that one may see on old brick buildings.

WAI appreciates the opportunity to work on this interesting project, please call if we may be of further assistance.

Sincerely,
Weidlinger Associates, Inc

Peter M. Wheelock

Peter M. Wheelock
Associate



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**City of Nashua, New Hampshire
Millyard Chimney Seismic and Wind Analysis**

July 11, 2011

Purpose:

The City of Nashua has engaged Weidlinger Associates, Inc. (WAI) to perform a seismic and wind lateral analysis of the Millyard Chimney. The Chimney is a historic feature of Nashua, which is currently part of a multi-phased Public Works project to build the Nashua Highway Connector.

Description:

The Chimney is located at 10 Technology Way, Nashua, which is generally referred to as the Millyard. It is a square brick structure that is 180 feet high with outside dimensions of 10'-3" by 10'-3" at the top and 18'-3" by 18'-3" at the base. It was built in the 1880's and we understand that historical records have not been located. Currently the top 15'-0" of brick have been removed, and a temporary concrete cap has been installed. Grade is at approximately elevation 150. The foundation was not identified, but is assumed to be granite blocks that are bearing at elevation 135 ft. or lower.

There are several key features of chimneys, such as the liner and breach. The chimney liner is designed to withstand high heat, corrosive fumes and vertical/horizontal thermal expansions and is separated from the outer structure by an air space. The liner is laterally braced with an air space but not connected to the outer structural brick walls. The liner bricks are yellow and at the top form a one wythe (one row of brick) wall of 8'-4" in diameter. The breach is the large opening at the base of the chimney where the horizontal flue passes through the wall and turns up the chimney. There are other openings at the base, such as a clean out hatch though which coal cinders are removed.

Documents:

- Boston Chimney and Tower, Inspection Report, 5/17/10. See Appendix.
- International Chimney Corporation, Wall Thickness Survey, email 4/15/11. See Appendix.
- Credere Associates, LLC drawings C-100, 101,102, C-300, 301 and S-101, 5/6/11. Site drawings which show an intermediate phase when the Boiler House and Coal Shed are scheduled to be demolished.
- Adjacent Boring Logs, see Appendix.

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Site Conditions and Phases:

Present Condition:

Presently, the chimney abuts the boiler house on south side and the coal shed on the east side. There appears to be approximately a 1" expansion joint between the boiler house and chimney; however, the joint between the coal shed and the chimney is more difficult to determine as there are areas of brick damage that will require repairs. Inspections from inside the adjacent buildings were not conducted due to a hazardous asbestos condition. The height of the chimney was recently lowered by 15'-0" due to bulging bricks at the top, which were a hazard.

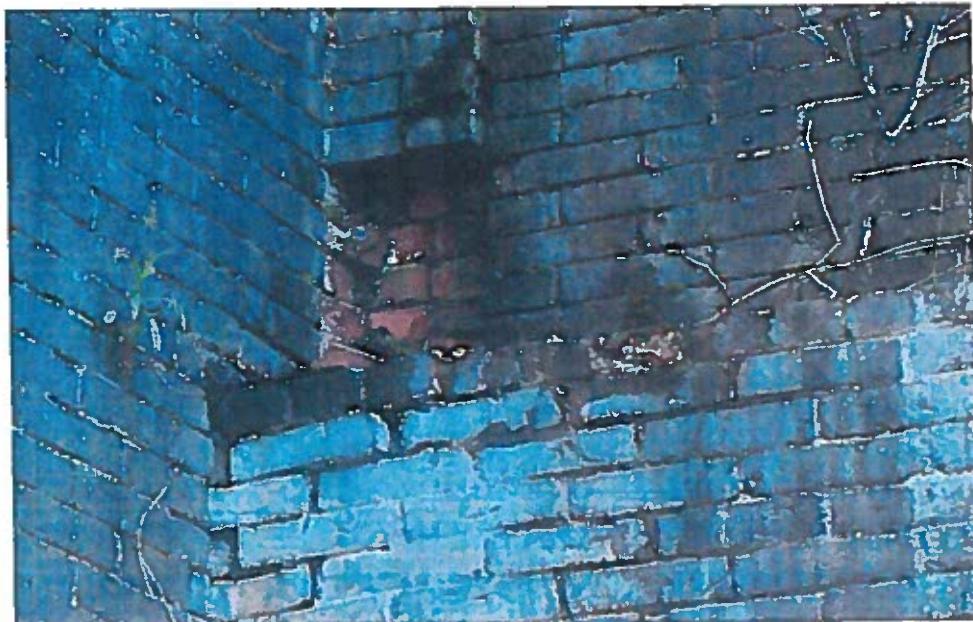


Picture 1. The Coal Shed (on the left) including the return and joint against the Chimney (right).

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Picture 2. A lower view of the Coal Shed and Chimney Joint.

Intermediate Phase:

We understand that the Boiler House and Coal Shed are scheduled to be demolished in this phase. The Credere drawings indicate that the adjacent foundation walls will remain, while the grade within the demolished building footprint will be approximately at elevation 142'-0". This will create an unequal soil load on the chimney of about 8ft, which will need to be reviewed (This scope of work was not part of our current effort.).

Final Phase:

We understand that in the final phase, the grade on all sides of the chimney will be at approximately elevation 150'-0" and the new Nashua Connector will have traffic lanes passing on either side of the Chimney.

WAI's analysis for this report is based on this final phase, where there is an equal soil pressure on all four sides of the chimney.

Analysis:

The New Hampshire State Building Code is based upon the International Building Code (IBC 2009) for new structures and, by logical extension, the International Existing Building Code (IEBC 2009). Both the IBC and IEBC reference the American Society of Civil Engineers, "Minimum Design Loads for Buildings and Other Structures" (ASCE 7 2005) for wind loads. A reference for the seismic analysis of unreinforced masonry structures is "Seismic Rehabilitation of Existing Buildings" (ASCE 41-06).

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Foundations and Soil:

The elevation, size and type of foundation and water table elevation are unknown. Based on the boring logs, the top layer of soil is fill and loose fine sands with low blow counts. Below the top layer there is a layer of medium dense sands and gravel starting at about elevation 130' to 135' (15' to 20' below grade). WAI has assumed that a granite block foundation was used for the chimney and that the foundation bears on the medium dense sand layer. Settlement issues do not appear to be common on this site. If the fill and find sand above the bearing elevation are within the water table they would be subject to liquefaction. However, the medium dense layer is not subject to liquefaction per the state code. This qualifies the chimney for a soil classification of D.

Brick Bearing Walls:

Given that the chimney is about 130 years old, it is reasonable to assume that there are structural issues. The structure has been both surveyed and repair specifications have been issued by others. Some, but not all, of the masonry issues are noted as follows:

1. Bulging walls, as noted by others at the top of the chimney, result when built up stresses have cracked the brick header course and the outer wythe separates and bulges out creating the hazard of falling bricks. The extent of header course damage is beyond the scope of this report.



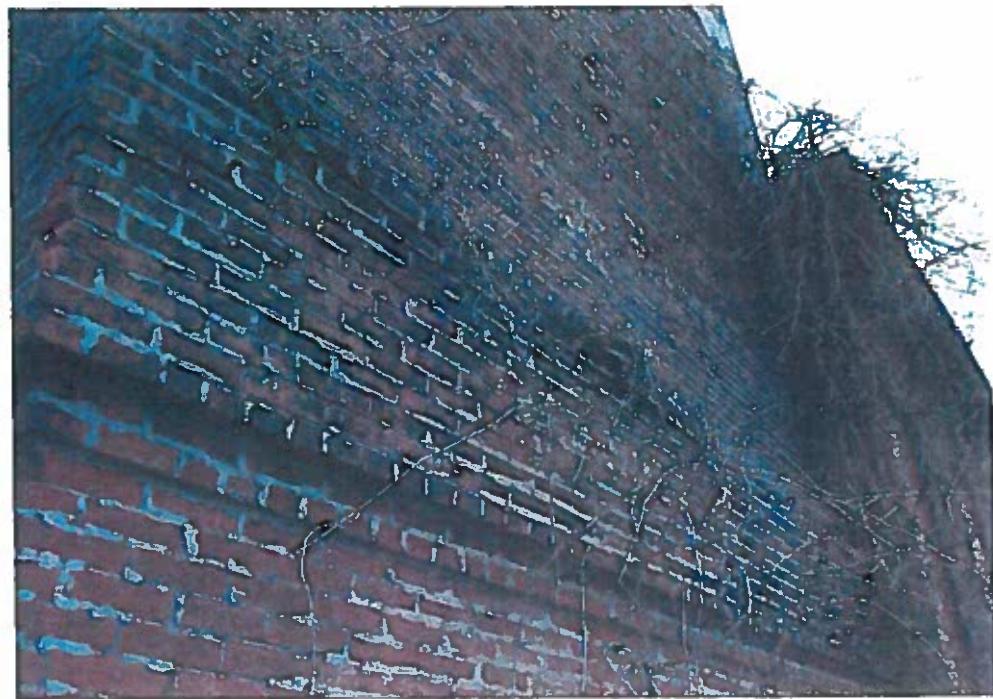
Picture 3. The bricks with their ends exposed are headers that tie two wythes together.

2. Loss or weakening of the masonry mortar due to weathering conditions at the outer wythe. The typical repair is to remove the loose and weak mortar and replace it with new mortar. That process is called repointing.

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Picture 4. This picture shows various levels and qualities of repointing of the masonry.

3. Lime rich mortar was commonly used for these solid brick bearing walls. When the exterior wythe became wet, the lime rich mortar would expand to seal the joints and keep the water from penetrating the wall. When water does penetrate the wall, the lime begins to dissolve and freeze thaw cycles degrade the mortar. The construction slang term for this mortar condition is sandy.

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Picture 5. This picture shows a pile of sand where a brick fell out on the Coal Shed building.

4. The bricks are fully fired, which implies that their rate of deterioration is slow, such that they remain sound.



Picture 6. Typical brick exposed surfaces, not original mortar.

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For these reasons, the strength of the mortar is of structural concern. In our opinion, although repointing will retard the chimney deterioration, it will not solve the mortar issues hidden in the inner wythes. For this reason, in place mortar strengths were not tested and determined, as the extreme spread of mortar quality indicates that testing would not be uniform to the point where it could be deemed misleading.

Based upon our experience, WAI used the following combined mortar and brick allowable stress:

Brick and mortar Compression	F _c = 300psi
Brick and mortar shear	V = 28 psi
Brick and mortar tension	F _t = 10 psi

Note:

The mortar tension (F_t) was the controlling factor in the analysis and, based upon the literature could range from 0 to 30 psi. The Pictures # 4 and # 5 demonstrate why a low allowable mortar tension stress (10 psi) is merited.

Other code related factors and allowable stresses are listed in the calculations. WAI assumed that the full cross section of the structural chimney was involved until tension- 0 psi for the seismic and 10 psi for the wind analysis at the outer edges was reached at which point the chimney was considered to have failed. The lateral capacity of the liner was considered to be zero, but the liner was included as part of the dead load of the structure.

Analysis Findings:

At the original full height (180') and the lower present height (150'), WAI found that the chimney does not meet the current code requirements for either wind loads or seismic loads. As for the wind loads, the ASCE 7 code includes a shape factor for rectangular chimneys that amplifies the base wind load. It is likely that the original design used lower wind loads (and did not account for this shape factor). Seismic loads were not considered in the 1880's.

WAI performed several analyses to determine what chimney height would conform to the most current code requirements.

One reduced chimney height to consider, which is included in this report, is 100 ft. At this height, the chimney meets the current requirement for wind loads. However, even at this lower height, the existing seismic capacity is only about 30% of the required strength.

WAI did not determine the exact height that meets the seismic requirements, but it is somewhere around 60 ft. or less.

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Recommendations:

Recommendations- Present condition and Intermediate condition:

1. Under the present conditions where the two buildings are adjacent to the chimney, a seismic hazard is created which has not examined as part of this report. Basically, during a seismic event, the buildings and chimney will hit and damage each other. If the plans for the connector are changed and the buildings are not removed, then this report would have to be revised.
2. During the intermediate phase, there is a note on the Credere drawing C-101 asking the owner or structural engineer of record (SER) to provide direction as to modifications to be made to the breach and other manifolds that penetrate the chimney walls. In our opinion, at a minimum, existing brick damage and demolition damage be exposed and shall be repaired. In addition, all steel and cast iron pipes and fitting should be removed from the brick chimney walls and the holes bricked solid.
3. During the intermediate phase, the chimney may be at a reduced lateral capacity due to unequal soil pressures, particularly when compared to the final condition. In terms of seismic designs, it is not the customary practice to assume that an event will occur during construction. However, we recommend that the wind load be considered at the full velocity of 93 mph.
4. Also, before the intermediate phase, the bottom of the chimney footing should be identified to avoid unknowingly excavating below the footing. To do so without engineering the underpinning or wall reinforcing could lead to unequal settlements. Furthermore, unequal soil loads on the granite foundation walls and chimney will need to be considered. The chimney footing may also project into or below the basement spaces.

Recommendations - Final Phase:

1. WAI is recommending that the chimney be lowered to a height of 120 feet, which will meet the requirements ASCE 7 design wind loads. As noted in this report, this height will sustain about 30% of the seismic design loads. This may be interpreted in the IEBC 2009 as repairs, arguing that lowering the height meets the intent of making a building sounder by repairing it. Then, this would be level 1 work that does not require a seismic analysis or upgrade. Conversely, it could be argued that lowering the chimney represents a large structural change that would require a lateral reinforcing upgrade to meet seismic requirements. WAI would suggest that a code consultant be retained by the owner to evaluate the implication of lowering the chimney.

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2. In our opinion, a variance may be sought, since this is treated a registered historical monument, which would allow the structure to be lowered to 120 ft. without upgrading the structure.
3. In our opinion, given the condition of the walls and that the top 85ft. are only three wythes (12") thick, it would be very difficult to upgrade this 165' structure. The liner would have to be removed and the work would be hazardous. A steel or concrete interior reinforcing would be costly and the reinforcing connections would be of a very low capacity.
4. At a height of about 100ft, we see a potential to upgrade the chimney. The top 15ft would be 12" thick and below that the wall thicknesses vary from 16" to 24" at the base. It would still be a difficult and costly job to undertake.
5. If a new height is eventually settled upon, it is important to include a new cap to keep the chimney dry, rebuilding the top ten feet to anchor the bricks, removing and replacing all loose or cracked bricks and repointing 100% of the façade with a mortar that has been designed for proper lime content.
6. For a final design, contract drawings, contract phase an proper outcome, it will be necessary to remove the inner liner, in order that the interior wall may be 100% repointed and tested.

Conclusion:

Our conclusion is that this chimney at its original height (or current 165') cannot meet the seismic or wind requirements of the New Hampshire State Building Code.



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- 2. THE FIVE STAGES
 - 3. THE BORN-TO-LEARN
 - 4. THE CHOOSE ONE
 - 5. MEMORANDUM
 - 6. DESIGN SUITE

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ANALYSIS & RESULTS

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1348-1349-1350-1351



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Pg. 1

- MEETING MINUTES
- CODE OBSERVATION
- TELEPHONE LOG
- MEMORANDUM
- DRAFT NOTES

PROJECT	AIC-1-CH101
WALL NUMBER	
MM	DATE
TELEPHONE NO.	DATE

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FAX	
PHONE	FAX
PAGE	00

SOURCE MATERIAL PROPERTIES - CLAY MORTAR

$$f_m' = 1000 \text{ psi}$$

$$E_m = 700 f_m' = 700 \text{ ksi}$$

$$E_v = 0.4 E_m = 280 \text{ ksi}$$

(MJSCE 2005-1 8.2.2.1)

(MJSCE 2005-1 8.2.2.2)

$$F_a = 300 \text{ psi}$$

$$F_l = 0 \text{ psi} \quad (10 \text{ psi})$$

$$F_g = 28 \text{ psi}$$

(IEBC 2009 A103.3)

(IEBC 2009 A108.4)

(MINIMUM FOR UNSTEED TYPE N MORTAR
BRICK INSTITUTE OF AMERICA, TN-24C)

$$f_{masonry} = 120 \text{ PCF}$$

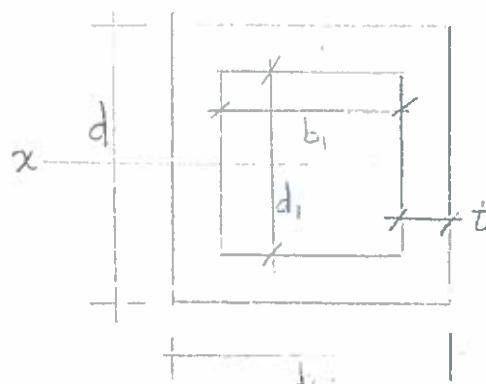
SECTION PROPERTIES

WALL THICKNESS	$A(\text{in}^2)$	$S_x(\text{in}^3)$	$I_{xx}(\text{in}^4)$
12"	5328	179982	11068920
16"	7360	252469	4536693
20"	9520	332424	73103953
24"	11808	420509	1090744

ACTIONS

$$S = \frac{b_1^3 - b_1 d_1^3}{6d}$$

$$I = \frac{b_1^3 - L_1^3}{12}$$



DISTRIBUTION



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- MAILING INFORMATION
- FAXED DRAWINGS
- TELEPHONE LOG
- MEMORY CARD
- DESIGN NOTES

PROJECT	NACEL CHIMNEY	
WAI NUMBER		
BY	AL	DATE
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TO	
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PHONE	
FAX	

SUBJECT DETERMINE SEISMIC COEFFICIENTS

$$a_p = 2.5$$

$$I_p^2 = 25$$

$$I_p = 1.0 ; \text{ IMPORTANCE FACTOR}$$

} (ASCE 41-06 TABLE II-2)

$$S_{xs} = S_{ds} = \frac{2}{3} S_{ms}$$

$$\begin{aligned} S_s &= 0.29 && ; 0.2s \text{ SPECTRAL ACCEL} \\ S_i &= 0.042 && ; 1.0s \text{ SPECTRAL ACCEL} \end{aligned} \quad \} (\text{IBC 2009 FIG 1613.5})$$

SITE CLASS D

$$F_a = 1.57$$

$$F_v = 2.4$$

$$\begin{aligned} S_{ms} &= F_a S_s = 0.455 \\ S_{mi} &= F_v S_i = 0.185 \end{aligned}$$

$$\begin{aligned} S_{ds} &= \frac{2}{3} S_{ms} = 0.303 \\ S_{di} &= \frac{2}{3} S_{mi} = 0.123 \end{aligned}$$

DETERMINE SEISMIC BASE SHEAR

$$F_p = \frac{0.4 a_p S_{ds} I_p W_p (1 + \frac{2x_h}{h})}{R_p} \quad (\text{ASCE 41-06 Eq II-4})$$

ACTION $F_{pmax} = 1.6 S_{ds} W_p \geq F_p \quad (\text{ASCE 41-06 Eq II-1})$

$$F_{pmin} = 0.3 S_{ds} I_p W_p \leq F_p \quad (\text{ASCE 41-06 Eq II-5})$$

x = ELEVATION OF CENTER OF GRAVITY

h = HEIGHT OF STRUCTURE

W_p = WEIGHT OF STRUCTURE OR COMPONENT



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- MAILING ADDRESS
- COLD INDUSTRIAL
- TELEPHONE LOG
- MEMORANDUM
- DESIGN NOTES

PROJECT	NASL-15 CANTILEVER	
WORK NUMBER		
BY	AL	DATE
CHECKED BY	DATE	

TO	
FROM	
PHONE	FAX
PAGE	OF

NOTES

AT $h=120$ FT, SEISMIC BASE SHEAR:

$$W_p = 1103 \text{ KIPS}$$

$$x = 73.6 \text{ FT}$$

$$F_p = 0.4(2.5)(0.303)(1.0)(1103) \left(1 + \frac{2(73.6)}{120}\right) = 243 \text{ KIPS}$$

$$F_{p_{max}} = 1.6(0.303)(1103) = 535 \text{ KIPS} > 243 \text{ K}$$

$$F_{p_{min}} = 0.3(0.303)(1.0)(1103) = 100. \text{ KIPS} < 243 \text{ K}$$

AT $h=100$ FT, SEISMIC BASE SHEAR:

$$W_p = 747.5 \text{ KIPS}$$

$$x = 42.1 \text{ FT}$$

$$F_p = 0.4(2.5)(0.303)(1.0)(747.5) \left(1 + \frac{2(42.1)}{100}\right) = 167 \text{ KIPS}$$

$$F_{p_{max}} = 1.6(0.303)(747.5) = 362 \text{ KIPS} > 167 \text{ K}$$

$$F_{p_{min}} = 0.3(0.303)(1.0)(747.5) = 68 \text{ KIPS} < 167 \text{ K}$$

DISTRIBUTION

**TABLE 1613.5.2
SITE CLASS DEFINITIONS**

SITE CLASS	SOIL PROFILE NAME	AVERAGE PROPERTIES IN TOP 100 feet, SEE SECTION 1613.5.5		
		Soil shear wave velocity, \bar{v}_{30} (ft/s)	Standard penetration resistance, \bar{N}	Soil undrained shear strength, \bar{s}_u (psf)
A	Hard rock	$\bar{v}_{30} > 5,000$	N/A	N/A
B	Rock	$2,500 < \bar{v}_{30} \leq 5,000$	N/A	N/A
C	Very dense soil and soft rock	$1,200 < \bar{v}_{30} \leq 2,500$	$\bar{N} > 50$	$\bar{s}_u \geq 2,000$
D	Stiff soil profile	$600 \leq \bar{v}_{30} \leq 1,200$	$15 \leq \bar{N} \leq 50$	$1,000 \leq \bar{s}_u \leq 2,000$
E	Soft soil profile	$\bar{v}_{30} < 600$	$\bar{N} < 15$	$\bar{s}_u < 1,000$
E	—	Any profile with more than 10 feet of soil having the following characteristics:		
		1. Plasticity index $PI > 20$,		
		2. Moisture content $w \geq 40\%$, and		
		3. Undrained shear strength $\bar{s}_u < 500$ psf		
F	—	Any profile containing soils having one or more of the following characteristics:		
		1. Soils vulnerable to potential failure or collapse under seismic loading such as liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils.		
		2. Peats and/or highly organic clays ($H > 10$ feet of peat and/or highly organic clay where H = thickness of soil)		
		3. Very high plasticity clays ($H > 25$ feet with plasticity index $PI > 75$)		
		4. Very thick soft/medium stiff clays ($H > 120$ feet)		

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m², 1 pound per square foot = 0.0479 kPa. N/A = Not applicable

**TABLE 1613.5.3(1)
VALUES OF SITE COEFFICIENT F_s^***

SITE CLASS	MAPPED SPECTRAL RESPONSE ACCELERATION AT SHORT PERIOD				
	$S_s \leq 0.25$	$S_s = 0.50$	$S_s = 0.75$	$S_s = 1.00$	$S_s \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	Note b	Note b	Note b	Note b	Note b

- a. Use straight-line interpolation for intermediate values of mapped spectral response acceleration at short period, S_s .
b. Values shall be determined in accordance with Section 11.4.7 of ASCE 7.

**TABLE 1613.5.3(2)
VALUES OF SITE COEFFICIENT F_1^***

SITE CLASS	MAPPED SPECTRAL RESPONSE ACCELERATION AT 1-SECOND PERIOD				
	$S_1 \leq 0.1$	$S_1 = 0.2$	$S_1 = 0.3$	$S_1 = 0.4$	$S_1 \geq 0.5$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	Note b	Note b	Note b	Note b	Note b

- a. Use straight-line interpolation for intermediate values of mapped spectral response acceleration at 1-second period, S_1 .
b. Values shall be determined in accordance with Section 11.4.7 of ASCE 7.

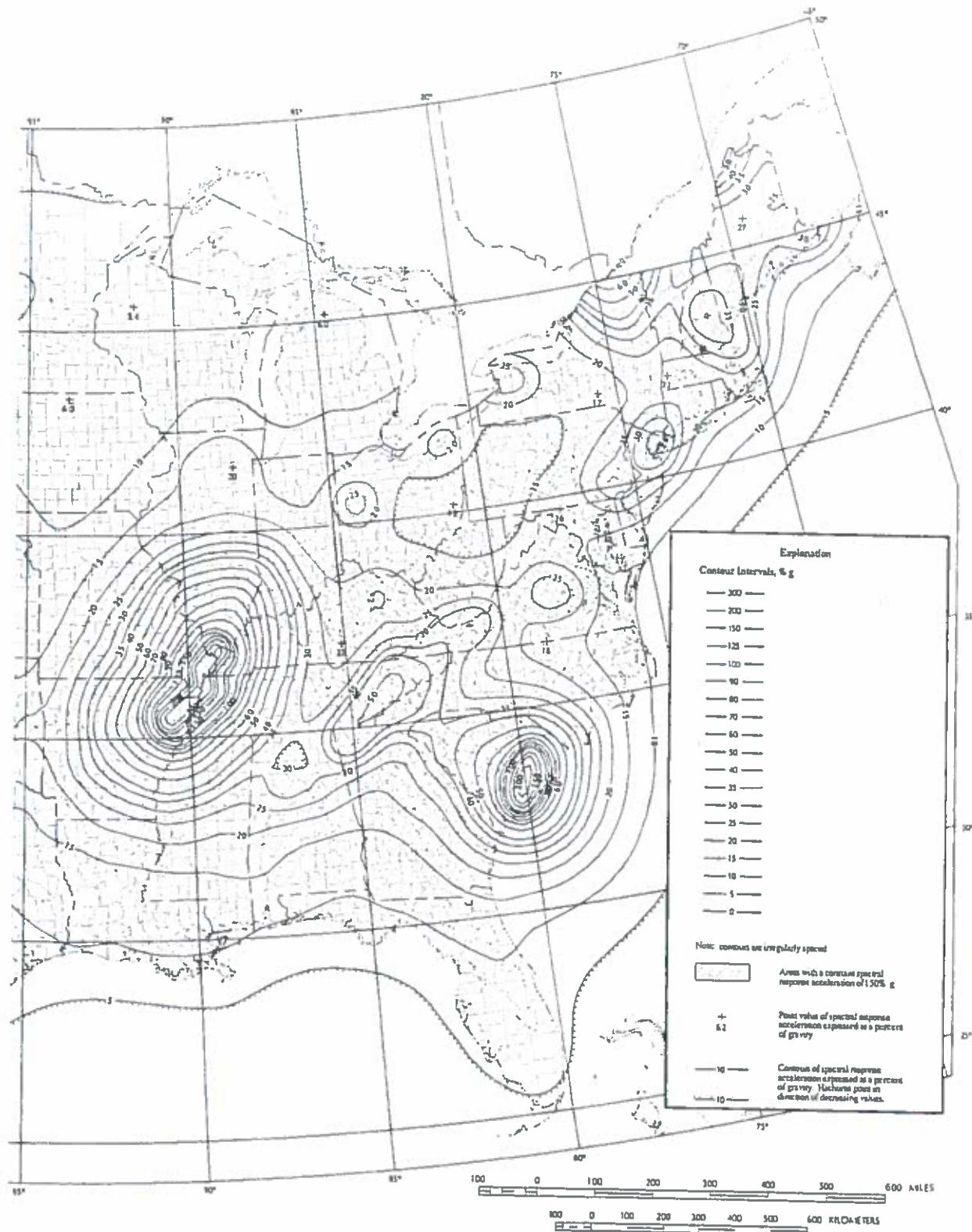


FIGURE 1613.5(1)—continued
MAXIMUM CONSIDERED EARTHQUAKE GROUND MOTION FOR THE CONTERMINOUS UNITED STATES OF
0.2 SEC SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING), SITE CLASS B

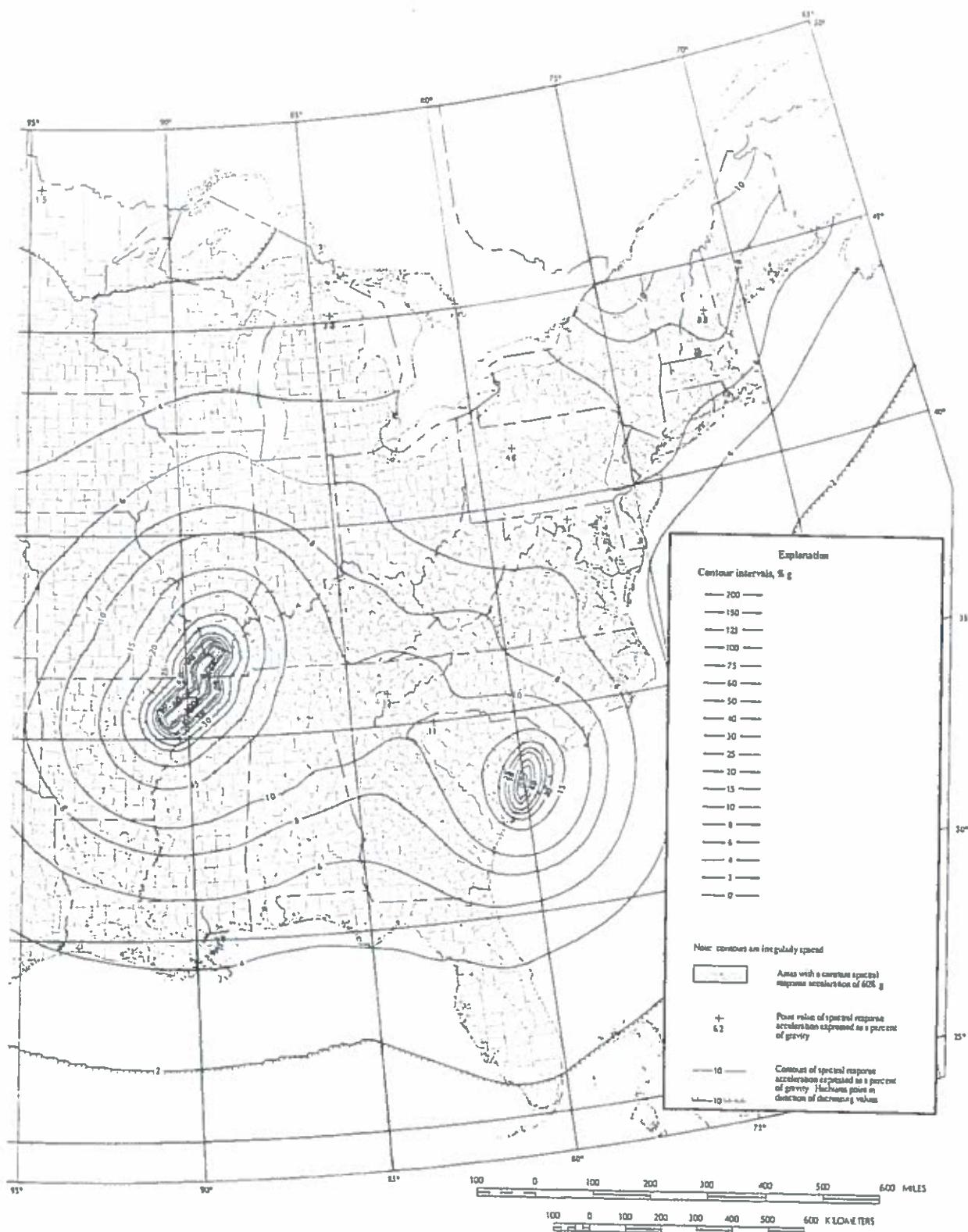


FIGURE 1613.5(2)—continued
MAXIMUM CONSIDERED EARTHQUAKE GROUND MOTION FOR THE CONTERMINOUS UNITED STATES
OF 1.0 SEC SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING), SITE CLASS B



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- MEETING MINUTES
- FIELD OBSERVATIONS
- TELEPHONE LOG
- TELEGRAMS
- DESIGN NOTES

PROJECT	NASLVA CTAUSE
WA# NUMBER	
DAY	
MONTH	
YEAR	
CHECKED BY	
DATE	

TO	
FIRM	
PHONE	
FAX	
EMAIL	

SUBJECT DETERMINE WIND LOAD

$$V = 93 \text{ MPH}$$

(ASCE 7-05 FIGURE 6-1C)

$$I = 1.0$$

EXPOSURE C

ROUGHNESS R

$$q_z = 0.00256 K_z K_{et} K_d V^2 I \quad (\text{ASCE 7-05 Eq 6-15})$$

$$K_d = 0.9 \text{ FOR CHIMNEY} \quad (\text{ASCE 7-05 TABLE 6-4})$$

$$K_z = 2.01 \left(\frac{z}{720} \right)^{2/9.5} \quad z \geq 15 \text{ FT} \quad (\text{ASCE 7-05 TABLE 6-3})$$

$$K_z = 6.01 \left(\frac{15}{720} \right)^{2/9.5} \quad z \leq 15 \text{ FT}$$

$$K_{et} = (1 + K_1 K_2 K_3)^2 = 1.0 \quad (\text{ASCE 7-05 Eq 6-3})$$

$$F = q_z G C_f A_f \quad (\text{ASCE 7-05 Eq 6-28})$$

$$C_f = \text{VARIES} \quad (\text{ASCE 7-05 FIG. 6-21})$$

$$G_f = \text{VARIES} \quad (\text{ASCE 7-05 6.5.8})$$

- FOR STRUCTURES WITH $T \geq 1.0s$ ($f < 1.0 H_z$)

USE SECTION 6.5.8.2

- FOR STRUCTURES WITH $T < 1.0s$ ($f > 1.0 H_z$)

USE $G_f = 0.85$

WIND BASE SHEAR @ 180' $\Rightarrow 65.3 \text{ k}$

WIND BASE SHEAR @ 100' $\Rightarrow 29.4 \text{ k}$

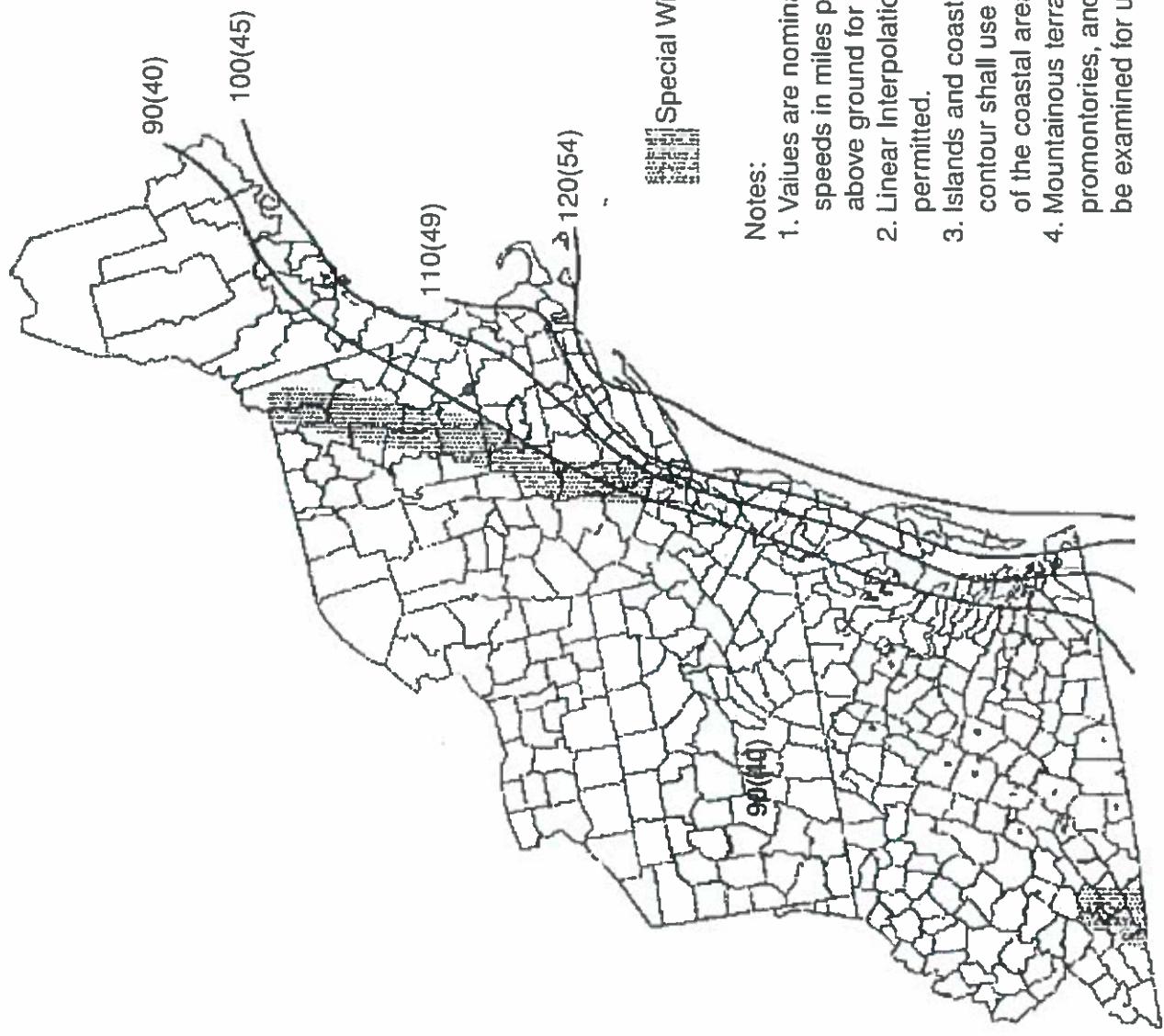


FIGURE 6-1C BASIC WIND SPEED—MID AND NORTHERN ATLANTIC HURRICANE COASTLINE

Velocity Pressure Exposure Coefficients, K_h and K_z

Table 6-3

Height above ground level, z		Exposure (Note 1)			
		B	C	D	
ft	(m)	Case 1	Case 2	Cases 1 & 2	Cases 1 & 2
0-15	(0-4.6)	0.70	0.57	0.85	1.03
20	(6.1)	0.70	0.62	0.90	1.08
25	(7.6)	0.70	0.66	0.94	1.12
30	(9.1)	0.70	0.70	0.98	1.16
40	(12.2)	0.76	0.76	1.04	1.22
50	(15.2)	0.81	0.81	1.09	1.27
60	(18)	0.85	0.85	1.13	1.31
70	(21.3)	0.89	0.89	1.17	1.34
80	(24.4)	0.93	0.93	1.21	1.38
90	(27.4)	0.96	0.96	1.24	1.40
100	(30.5)	0.99	0.99	1.26	1.43
120	(36.6)	1.04	1.04	1.31	1.48
140	(42.7)	1.09	1.09	1.36	1.52
160	(48.8)	1.13	1.13	1.39	1.55
180	(54.9)	1.17	1.17	1.43	1.58
200	(61.0)	1.20	1.20	1.46	1.61
250	(76.2)	1.28	1.28	1.53	1.68
300	(91.4)	1.35	1.35	1.59	1.73
350	(106.7)	1.41	1.41	1.64	1.78
400	(121.9)	1.47	1.47	1.69	1.82
450	(137.2)	1.52	1.52	1.73	1.86
500	(152.4)	1.56	1.56	1.77	1.89

Notes:

1. **Case 1:**
 - a. All components and cladding.
 - b. Main wind force resisting system in low-rise buildings designed using Figure 6-10.
2. **Case 2:**
 - a. All main wind force resisting systems in buildings except those in low-rise buildings designed using Figure 6-10.
 - b. All main wind force resisting systems in other structures.

2. The velocity pressure exposure coefficient K_z may be determined from the following formula:

For $15 \text{ ft.} \leq z \leq z_g$

For $z < 15 \text{ ft.}$

$$K_z = 2.01 (z/z_g)^{2/\alpha}$$

$$K_z = 2.01 (15/z_g)^{2/\alpha}$$

Note: z shall not be taken less than 30 feet for Case 1 in exposure B.

3. α and z_g are tabulated in Table 6-2.
4. Linear interpolation for intermediate values of height z is acceptable.
5. Exposure categories are defined in 6.5.6.

Wind Directionality Factor, K_d

Table 6-4

Structure Type	Directionality Factor K_d^*
Buildings Main Wind Force Resisting System Components and Cladding	0.85 0.85
Arched Roofs	0.85
Chimneys, Tanks, and Similar Structures Square Hexagonal Round	0.90 0.95 0.95
Solid Signs	0.85
Open Signs and Lattice Framework	0.85
Trussed Towers Triangular, square, rectangular All other cross sections	0.85 0.95

*Directionality Factor K_d has been calibrated with combinations of loads specified in Section 2. This factor shall only be applied when used in conjunction with load combinations specified in 2.3 and 2.4.

Other Structures – Method 2		All Heights		
Figure 6-21	Force Coefficients, C_f	Chimneys, Tanks, Rooftop Equipment, & Similar Structures		
Cross-Section		Type of Surface		
		h/D		
		1	7	25
Square (wind normal to face)	All	1.3	1.4	2.0
Square (wind along diagonal)	All	1.0	1.1	1.5
Hexagonal or octagonal	All	1.0	1.2	1.4
Round ($D\sqrt{q_z} > 2.5$) ($D\sqrt{q_z} > 5.3$, D in m, q_z in N/m ²)	Moderately smooth	0.5	0.6	0.7
	Rough ($D'/D = 0.02$)	0.7	0.8	0.9
	Very rough ($D'/D = 0.08$)	0.8	1.0	0.2
Round ($D\sqrt{q_z} \leq 2.5$) ($D\sqrt{q_z} \leq 5.3$, D in m, q_z in N/m ²)	All	0.7	0.8	1.2

Notes:

1. The design wind force shall be calculated based on the area of the structure projected on a plane normal to the wind direction. The force shall be assumed to act parallel to the wind direction.
2. Linear interpolation is permitted for h/D values other than shown.
3. Notation:

D : diameter of circular cross-section and least horizontal dimension of square, hexagonal or octagonal cross-sections at elevation under consideration, in feet (meters);

D' : depth of protruding elements such as ribs and spoilers, in feet (meters); and

h : height of structure, in feet (meters); and

q_z : velocity pressure evaluated at height z above ground, in pounds per square foot (N/m²).

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$h = 180 \text{ ft}$



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Table: Modal Periods And Frequencies

OutputCase	StepType	StepNum	Period Sec	Frequency Cyc/sec	CircFreq rad/sec	Eigenvalue rad ² /sec ²
MODAL	Mode	1.000000	<u>2.041916</u>	<u>4.8974E-01</u>	3.0771E+00	9.4686E+00
MODAL	Mode	2.000000	2.041916	4.8974E-01	3.0771E+00	9.4686E+00
MODAL	Mode	3.000000	0.428567	2.3334E+00	1.4661E+01	2.1494E+02
MODAL	Mode	4.000000	0.428567	2.3334E+00	1.4661E+01	2.1494E+02
MODAL	Mode	5.000000	0.171720	5.8234E+00	3.6590E+01	1.3388E+03
MODAL	Mode	6.000000	0.171720	5.8234E+00	3.6590E+01	1.3388E+03
MODAL	Mode	7.000000	0.114977	8.6974E+00	5.4647E+01	2.9863E+03
MODAL	Mode	8.000000	0.093601	1.0684E+01	6.7127E+01	4.5060E+03
MODAL	Mode	9.000000	0.093601	1.0684E+01	6.7127E+01	4.5060E+03
MODAL	Mode	10.000000	0.061021	1.6388E+01	1.0297E+02	1.0602E+04
MODAL	Mode	11.000000	0.061021	1.6388E+01	1.0297E+02	1.0602E+04
MODAL	Mode	12.000000	0.045742	2.1862E+01	1.3736E+02	1.8868E+04

$$T = 2.04 \text{ s}$$

$$f = 0.49 \text{ Hz} \quad \text{A FLEXIBLE STRUCTURE}$$

frame forces_180ft

AXIAL EFFECTS

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Ht	Area (in ²)	Area (ft ²)	Weight	h*W	P (k)	F _a (ksi)
180	5328	37.0	4.44	797.0	4.44	0.001
178	5328	37.0	8.88	1580.6	13.32	0.003
176	5328	37.0	8.88	1562.9	22.20	0.004
174	5328	37.0	8.88	1545.1	31.08	0.006
172	5328	37.0	8.88	1527.4	39.96	0.008
170	5328	37.0	8.88	1509.6	48.84	0.009
168	5328	37.0	8.88	1491.8	57.72	0.011
166	5328	37.0	8.88	1474.1	66.60	0.013
164	5328	37.0	8.88	1456.3	75.48	0.014
162	5328	37.0	8.88	1438.6	84.36	0.016
160	5328	37.0	8.88	1420.8	93.24	0.018
158	5328	37.0	8.88	1403.0	102.12	0.019
156	5328	37.0	8.88	1385.3	111.00	0.021
154	5328	37.0	8.88	1367.5	119.88	0.023
152	5328	37.0	8.88	1349.8	128.76	0.024
150	5328	37.0	8.88	1332.0	137.64	0.026
148	5328	37.0	8.88	1314.2	146.52	0.028
146	5328	37.0	8.88	1296.5	155.40	0.029
144	5328	37.0	8.88	1278.7	164.28	0.031
142	5328	37.0	8.88	1261.0	173.16	0.033
140	5328	37.0	8.88	1243.2	182.04	0.034
138	5328	37.0	8.88	1225.4	190.92	0.036
136	5328	37.0	8.88	1207.7	199.80	0.038
134	5328	37.0	8.88	1189.9	208.68	0.039
132	5328	37.0	8.88	1172.2	217.56	0.041
130	5328	37.0	8.88	1154.4	226.44	0.043
128	5328	37.0	8.88	1136.6	235.32	0.044
126	5328	37.0	8.88	1118.9	244.20	0.046
124	5328	37.0	8.88	1101.1	253.08	0.048
122	5328	37.0	8.88	1083.4	261.96	0.049
120	5328	37.0	8.88	1065.6	270.84	0.051
118	5328	37.0	8.88	1047.8	279.72	0.053
116	5328	37.0	8.88	1030.1	288.60	0.054
114	5328	37.0	8.88	1012.3	297.48	0.056
112	5328	37.0	8.88	994.6	306.36	0.058
110	5328	37.0	8.88	976.8	315.24	0.059
108	5328	37.0	8.88	959.0	324.12	0.061
106	5328	37.0	8.88	941.3	333.00	0.063
104	5328	37.0	8.88	923.5	341.88	0.064
102	5328	37.0	8.88	905.8	350.76	0.066
100	5328	37.0	8.88	888.0	359.64	0.068
98	5328	37.0	8.88	870.2	368.52	0.069
96	5328	37.0	8.88	852.5	377.40	0.071
94	5328	37.0	8.88	834.7	386.28	0.073
92	5328	37.0	8.88	817.0	395.16	0.074
90	5328	37.0	8.88	799.2	404.04	0.076

frame forces_180ft

AXIAL EFFECTS

88	5328	37.0	8.88	781.4	412.92	0.078
86	5328	37.0	8.88	763.7	421.80	0.079
84	5328	37.0	8.88	745.9	430.68	0.081
82	5328	37.0	8.88	728.2	439.56	0.082
80	5734	39.8	9.56	764.6	449.12	0.078
78	6141	42.6	10.23	798.3	459.35	0.075
76	6547	45.5	10.91	829.3	470.26	0.072
74	6954	48.3	11.59	857.6	481.85	0.069
72	7360	51.1	12.27	883.2	494.12	0.067
70	7360	51.1	12.27	858.7	506.39	0.069
68	7360	51.1	12.27	834.1	518.65	0.070
66	7360	51.1	12.27	809.6	530.92	0.072
64	7360	51.1	12.27	785.1	543.19	0.074
62	7360	51.1	12.27	760.5	555.45	0.075
60	7792	54.1	12.99	779.2	568.44	0.073
58	8224	57.1	13.71	795.0	582.15	0.071
56	8656	60.1	14.43	807.9	596.57	0.069
54	9088	63.1	15.15	817.9	611.72	0.067
52	9520	66.1	15.87	825.1	627.59	0.066
50	9520	66.1	15.87	793.3	643.45	0.068
48	9520	66.1	15.87	761.6	659.32	0.069
46	9520	66.1	15.87	729.9	675.19	0.071
44	9520	66.1	15.87	698.1	691.05	0.073
42	9520	66.1	15.87	666.4	706.92	0.074
40	9978	69.3	16.63	665.2	723.55	0.073
38	10435	72.5	17.39	660.9	740.94	0.071
36	10893	75.6	18.15	653.6	759.10	0.070
34	11350	78.8	18.92	643.2	778.01	0.069
32	11808	82.0	19.68	629.8	797.69	0.068
30	11808	82.0	19.68	590.4	817.37	0.069
28	11808	82.0	19.68	551.0	837.05	0.071
26	11808	82.0	19.68	511.7	856.73	0.073
24	11808	82.0	19.68	472.3	876.41	0.074
22	11808	82.0	19.68	433.0	896.09	0.076
20	11808	82.0	19.68	393.6	915.77	0.078
18	11808	82.0	19.68	354.2	935.45	0.079
16	11808	82.0	19.68	314.9	955.13	0.081
14	11808	82.0	19.68	275.5	974.81	0.083
12	11808	82.0	19.68	236.2	994.49	0.084
10	11808	82.0	19.68	196.8	1014.17	0.086
8	11808	82.0	19.68	157.4	1033.85	0.088
6	11808	82.0	19.68	118.1	1053.53	0.089
4	11808	82.0	19.68	78.7	1073.21	0.091
2	11808	82.0	19.68	39.4	1092.89	0.093
0	11808	82.0	9.84	4.92	1102.73	0.093
				1102.73	81198.7	

frame forces_180ft

WIND EFFECTS

V Kd	93 mph 0.9										[ASCE 7-05 Table 6-4]			
Ht. (ft)	Width	Aproj (ft^2)	A*h	Kz	qz	F (lbs)	V (k)	M (k-ft)	A	Sx	f _v	f _b		
180	10.25	10.25	1839.88	1.43	28.54	424,6108	0.42	0.0	5328	179982	0.000	0.000		
178	10.25	20.50	3649.00	1.43	28.48	847,2263	1.27	1.7	5328	179982	0.000	0.000		
176	10.25	20.50	3608.00	1.43	28.41	845,2132	2.12	5.1	5328	179982	0.000	0.000		
174	10.25	20.50	3567.00	1.42	28.34	843,1821	2.96	10.2	5328	179982	0.001	0.001		
172	10.25	20.50	3526.00	1.42	28.27	841,1324	3.80	16.9	5328	179982	0.001	0.001		
170	10.25	20.50	3485.00	1.42	28.20	839,0638	4.64	25.4	5328	179982	0.001	0.001		
168	10.25	20.50	3444.00	1.41	28.13	836,9759	5.48	35.5	5328	179982	0.001	0.002		
166	10.25	20.50	3403.00	1.41	28.06	834,8683	6.31	47.3	5328	179982	0.001	0.002		
164	10.25	20.50	3362.00	1.40	27.99	832,7405	7.15	60.7	5328	179982	0.001	0.003		
162	10.25	20.50	3321.00	1.40	27.92	830,5922	7.98	75.9	5328	179982	0.001	0.004		
160	10.25	20.50	3280.00	1.40	27.84	828,4228	8.80	92.6	5328	179982	0.001	0.005		
158	10.25	20.50	3239.00	1.39	27.77	826,2319	9.63	111.1	5328	179982	0.002	0.006		
156	10.25	20.50	3198.00	1.39	27.70	824,019	10.45	131.1	5328	179982	0.002	0.007		
154	10.25	20.50	3157.00	1.39	27.62	821,7836	11.28	152.9	5328	179982	0.002	0.009		
152	10.25	20.50	3116.00	1.38	27.54	819,5251	12.10	176.3	5328	179982	0.002	0.010		
150	10.25	20.50	3075.00	1.38	27.47	817,2431	12.91	201.3	5328	179982	0.002	0.012		
148	10.25	20.50	3034.00	1.37	27.39	814,9369	13.73	227.9	5328	179982	0.002	0.013		
146	10.25	20.50	2993.00	1.37	27.31	812,606	14.54	256.2	5328	179982	0.003	0.015		
144	10.25	20.50	2952.00	1.37	27.23	810,2497	15.35	286.1	5328	179982	0.003	0.017		
142	10.25	20.50	2911.00	1.36	27.15	807,8675	16.16	317.6	5328	179982	0.003	0.019		
140	10.25	20.50	2870.00	1.36	27.07	805,4586	16.96	350.7	5328	179982	0.003	0.021		
138	10.25	20.50	2829.00	1.35	26.99	803,0224	17.77	385.4	5328	179982	0.003	0.023		
136	10.25	20.50	2788.00	1.35	26.91	800,5581	18.57	421.8	5328	179982	0.003	0.026		
134	10.25	20.50	2747.00	1.35	26.82	798,0651	19.37	459.7	5328	179982	0.004	0.028		
132	10.25	20.50	2706.00	1.34	26.74	795,5425	20.16	499.2	5328	179982	0.004	0.031		
130	10.25	20.50	2665.00	1.34	26.65	792,9896	20.95	540.3	5328	179982	0.004	0.033		
128	10.25	20.50	2624.00	1.33	26.57	790,4055	21.74	583.0	5328	179982	0.004	0.036		
126	10.25	20.50	2583.00	1.33	26.48	787,7893	22.53	627.3	5328	179982	0.004	0.039		
124	10.25	20.50	2542.00	1.32	26.39	785,1401	23.32	673.2	5328	179982	0.004	0.042		
122	10.25	20.50	2501.00	1.32	26.30	782,4569	24.10	720.6	5328	179982	0.005	0.045		
120	10.25	20.50	2460.00	1.32	26.21	779,7388	24.88	769.6	5328	179982	0.005	0.048		
118	10.25	20.50	2419.00	1.31	26.11	776,9847	25.66	820.1	5328	179982	0.005	0.051		
116	10.25	20.50	2378.00	1.31	26.02	774,1935	26.43	872.2	5328	179982	0.005	0.055		
114	10.25	20.50	2337.00	1.30	25.93	771,364	27.20	925.8	5328	179982	0.005	0.058		
112	10.25	20.50	2296.00	1.30	25.83	768,4951	27.97	981.0	5328	179982	0.005	0.062		
110	10.25	20.50	2255.00	1.29	25.73	765,5854	28.74	1037.7	5328	179982	0.005	0.065		
108	10.25	20.50	2214.00	1.29	25.63	762,6337	29.50	1095.9	5328	179982	0.006	0.069		
106	10.25	20.50	2173.00	1.28	25.53	759,6385	30.26	1155.7	5328	179982	0.006	0.073		
104	10.25	20.50	2132.00	1.28	25.43	756,5983	31.02	1217.0	5328	179982	0.006	0.077		
102	10.25	20.50	2091.00	1.27	25.33	753,5117	31.77	1279.7	5328	179982	0.006	0.081		
100	10.25	20.50	2050.00	1.27	25.22	750,3768	32.52	1344.0	5328	179982	0.006	0.085		
98	10.25	20.50	2009.00	1.26	25.11	747,1921	33.27	1409.8	5328	179982	0.006	0.090		
96	10.25	20.50	1968.00	1.25	25.00	743,9556	34.01	1477.1	5328	179982	0.006	0.094		
94	10.25	20.50	1927.00	1.25	24.89	740,6655	34.75	1545.9	5328	179982	0.006	0.098		
92	10.25	20.50	1886.00	1.24	24.78	737,3196	35.49	1616.1	5328	179982	0.007	0.103		
90	10.25	20.50	1845.00	1.24	24.67	733,9158	36.22	1687.8	5328	179982	0.007	0.108		
88	10.25	20.50	1804.00	1.23	24.55	730,4518	36.95	1761.0	5328	179982	0.007	0.113		
86	10.25	20.50	1763.00	1.23	24.43	726,925	37.68	1835.6	5328	179982	0.007	0.117		
84	10.25	20.50	1722.00	1.22	24.31	723,3329	38.40	1911.7	5328	179982	0.007	0.122		
82	10.25	20.50	1681.00	1.21	24.19	719,6726	39.12	1989.2	5734	192479	0.007	0.127		
80	10.25	20.50	1640.00	1.21	24.06	715,9411	39.84	2068.2	6141	204977	0.006	0.131		
78	10.25	20.50	1599.00	1.20	23.94	712,1353	40.55	2148.6	6547	217474	0.006	0.135		
76	10.25	20.50	1558.00	1.19	23.80	708,2516	41.26	2230.4	6954	229972	0.006	0.139		
74	10.25	20.50	1517.00	1.19	23.67	704,2863	41.96	2313.6	7360	242469	0.006	0.143		
72	10.25	21.83	1572.00	1.18	23.54	745,7816	42.71	2398.3	7360	242469	0.006	0.145		
70	10.25	21.83	1528.34	1.17	23.40	741,3717	43.45	2484.4	7360	242469	0.006	0.149		
68	10.25	21.83	1484.67	1.17	23.25	736,8611	44.19	2572.1	7360	242469	0.006	0.153		

frame forces_180ft

WIND EFFECTS

66	10.92	21.83	1441.00	1.16	23.11	732.2446	44.92	2661.2	7360	242469	0.006	0.132
64	10.92	21.83	1397.34	1.15	22.96	727.5163	45.65	2751.7	7360	242469	0.006	0.136
62	10.92	21.83	1353.67	1.14	22.81	722.6698	46.37	2843.8	7792	260460	0.006	0.131
60	10.92	21.83	1310.00	1.14	22.65	717.6983	47.09	2937.2	8224	278451	0.006	0.127
58	10.92	21.83	1266.34	1.13	22.49	712.5942	47.80	3032.1	8656	296442	0.006	0.123
56	10.92	21.83	1222.67	1.12	22.32	707.3492	48.51	3128.4	9088	314433	0.005	0.119
54	10.92	23.16	1250.64	1.11	22.15	744.605	49.25	3226.2	9520	332424	0.005	0.116
52	11.58	23.17	1204.63	1.10	21.98	738.9037	49.99	3325.4	9520	332424	0.005	0.120
50	11.58	23.17	1158.30	1.09	21.80	732.8277	50.72	3426.1	9520	332424	0.005	0.124
48	11.58	23.17	1111.97	1.08	21.61	726.5567	51.45	3528.3	9520	332424	0.005	0.127
46	11.58	23.17	1065.64	1.07	21.42	720.0759	52.17	3631.9	9520	332424	0.005	0.131
44	11.58	23.17	1019.30	1.06	21.22	713.3686	52.88	3737.0	9520	332424	0.006	0.135
42	11.58	23.17	972.97	1.05	21.01	706.4162	53.59	3843.4	9978	350041	0.005	0.132
40	11.72	23.43	937.31	1.04	20.80	707.2499	54.30	3951.3	10435	367658	0.005	0.129
38	11.82	23.65	898.56	1.03	20.57	706.0266	55.00	4060.6	10893	385275	0.005	0.126
36	11.91	23.82	857.41	1.02	20.34	703.0763	55.71	4171.3	11350	402892	0.005	0.124
34	11.98	23.95	814.42	1.01	20.10	698.6509	56.40	4283.4	11808	420509	0.005	0.122
32	12.25	24.50	784.00	1.00	19.84	705.5255	57.11	4397.0	11808	420509	0.005	0.125
30	12.25	24.50	735.00	0.98	19.57	696.0043	57.81	4511.9	11808	420509	0.005	0.129
28	12.25	24.50	686.00	0.97	19.29	685.968	58.49	4628.2	11808	420509	0.005	0.132
26	12.25	24.50	637.00	0.95	18.99	675.3488	59.17	4745.8	11808	420509	0.005	0.135
24	12.25	24.50	588.00	0.94	18.68	664.0638	59.83	4864.8	11808	420509	0.005	0.139
22	12.25	24.50	539.00	0.92	18.34	652.0101	60.48	4985.2	11808	420509	0.005	0.142
20	12.25	24.50	490.00	0.90	17.97	639.0577	61.12	5106.8	11808	420509	0.005	0.146
18	12.25	24.50	441.00	0.88	17.58	625.0387	61.75	5229.6	11808	420509	0.005	0.149
16	12.25	24.50	392.00	0.86	17.15	609.7305	62.36	5353.7	11808	420509	0.005	0.153
14	12.25	24.50	343.00	0.85	16.92	601.5021	62.96	5479.1	11808	420509	0.005	0.156
12	12.25	24.50	294.00	0.85	16.92	601.5021	63.56	5605.6	11808	420509	0.005	0.160
10	12.25	24.50	245.00	0.85	16.92	601.5021	64.16	5733.3	11808	420509	0.005	0.164
8	12.25	24.50	196.00	0.85	16.92	601.5021	64.76	5862.2	11808	420509	0.005	0.167
6	12.25	24.50	147.00	0.85	16.92	601.5021	65.37	5992.4	11808	420509	0.006	0.171
4	12.25	24.50	98.00	0.85	16.92	601.5021	65.97	6123.7	11808	420509	0.006	0.175
2	12.25	24.50	49.00	0.85	16.92	601.5021	66.57	6256.2	11808	420509	0.006	0.179
0	12.25	12.25	6.13	0.85	16.92	300.7511	66.87	6389.7	11808	420509	0.006	0.182

1955 169276

$$F = 69.30 \text{ kips} \quad F = q_t * C_f * G * A_f \quad (\text{ASCE 7-05 Eq. 6-28})$$

$$A_f = 1955 \text{ ft}^2$$

$$CoA = 86.6 \text{ ft}$$

$$q_{CoA} = 24.43 \text{ psf}$$

$$C_f = 1.66$$

(ASCE 7-05 Fig. 6-21)

$$G_f = 0.87$$

(ASCE 7-05 Eq. 6-8)

Calculation of G_f for flexible structures:

(ASCE 7-05 6.5.8.2)

$$I_{t-bar} = 0.16 \quad (\text{ASCE 7-05 Eq. 6-5})$$

$$C = 0.20$$

(ASCE 7-05 Table 6-2)

$$Q = 0.878$$

(ASCE 7-05 Eq. 6-6)

$$B = 10.88$$

$$h = 180$$

$$L = 10.88$$

$$L_{t-bar} = 634 \quad (\text{ASCE 7-05 Eq. 6-7})$$

$$I = 500 \quad (\text{ASCE 7-05 Table 6-2})$$

$$z-bar = 108$$

$$c = 0.2$$

(ASCE 7-05 Table 6-2)

$$B_Q = 3.4$$

$$G_v = 3.4$$

(ASCE 7-05 Eq. 6-9)

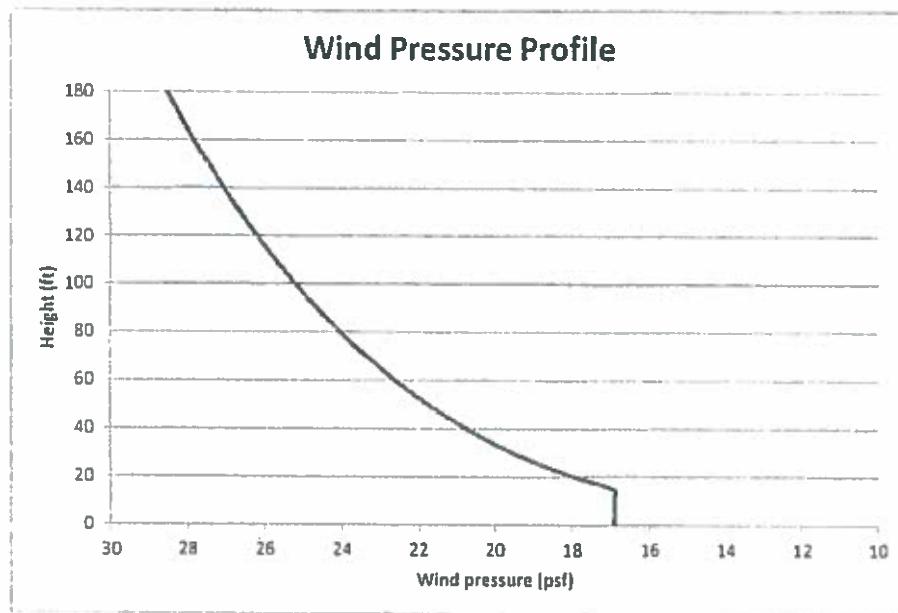
$$G_a = 4.019$$

$$n_1 = 0.496$$

(ASCE 7-05 Eq. 6-12)

$$N_1 = 2.95$$

$V_{1-bar} =$	106.4	(ASCE 7-05 Eq. 6-14)
$b-bar =$	0.65	(ASCE 7-05 Table 6-2)
$a =$	0.15	(ASCE 7-05 Table 6-2)
$R =$	0.106	(ASCE 7-05 Eq. 6-10)
$\beta =$	1	
$R_n =$	0.071	(ASCE 7-05 Eq. 6-11)
$R_h =$	0.226	(ASCE 7-05 Eq. 6-13a)
$\eta =$	3.860	
$R_B =$	0.861	(ASCE 7-05 Eq. 6-13a)
$\eta =$	0.233	
$R_L =$	0.633	(ASCE 7-05 Eq. 6-13a)
$\eta =$	0.781	



frame forces_180ft

SEISMIC EFFECTS

Tg. 10

Ht	A (in^2)	A(ft^2)	Weight	h*W	Σh^*w	Fx (k)	V (k)	M (k-ft)	S (in^3)	Fv (ksi)	Fb (ksi)
180	5328	37.0	4.44	797.0	0.010	2.39	2	0	179982	0.000	0.000
178	5328	37.0	8.88	1580.6	0.019	4.73	7	10	179982	0.001	0.001
176	5328	37.0	8.88	1562.9	0.019	4.68	12	28	179982	0.002	0.002
174	5328	37.0	8.88	1545.1	0.019	4.62	16	57	179982	0.003	0.004
172	5328	37.0	8.88	1527.4	0.019	4.57	21	94	179982	0.004	0.006
170	5328	37.0	8.88	1509.6	0.019	4.52	26	141	179982	0.005	0.009
168	5328	37.0	8.88	1491.8	0.018	4.46	30	196	179982	0.006	0.013
166	5328	37.0	8.88	1474.1	0.018	4.41	34	260	179982	0.006	0.017
164	5328	37.0	8.88	1456.3	0.018	4.36	39	333	179982	0.007	0.022
162	5328	37.0	8.88	1438.6	0.018	4.31	43	415	179982	0.008	0.028
160	5328	37.0	8.88	1420.8	0.017	4.25	47	506	179982	0.009	0.034
158	5328	37.0	8.88	1403.0	0.017	4.20	51	604	179982	0.010	0.040
156	5328	37.0	8.88	1385.3	0.017	4.15	56	712	179982	0.010	0.047
154	5328	37.0	8.88	1367.5	0.017	4.09	60	827	179982	0.011	0.055
152	5328	37.0	8.88	1349.8	0.017	4.04	64	950	179982	0.012	0.063
150	5328	37.0	8.88	1332.0	0.016	3.99	68	1082	179982	0.013	0.072
148	5328	37.0	8.88	1314.2	0.016	3.93	72	1221	179982	0.013	0.081
146	5328	37.0	8.88	1296.5	0.016	3.88	76	1369	179982	0.014	0.091
144	5328	37.0	8.88	1278.7	0.016	3.83	79	1524	179982	0.015	0.102
142	5328	37.0	8.88	1261.0	0.016	3.77	83	1686	179982	0.016	0.112
140	5328	37.0	8.88	1243.2	0.015	3.72	87	1856	179982	0.016	0.124
138	5328	37.0	8.88	1225.4	0.015	3.67	91	2034	179982	0.017	0.136
136	5328	37.0	8.88	1207.7	0.015	3.61	94	2218	179982	0.018	0.148
134	5328	37.0	8.88	1189.9	0.015	3.56	98	2410	179982	0.018	0.161
132	5328	37.0	8.88	1172.2	0.014	3.51	101	2609	179982	0.019	0.174
130	5328	37.0	8.88	1154.4	0.014	3.45	105	2815	179982	0.020	0.188
128	5328	37.0	8.88	1136.6	0.014	3.40	108	3028	179982	0.020	0.202
126	5328	37.0	8.88	1118.9	0.014	3.35	111	3248	179982	0.021	0.217
124	5328	37.0	8.88	1101.1	0.014	3.30	115	3474	179982	0.022	0.232
122	5328	37.0	8.88	1083.4	0.013	3.24	118	3707	179982	0.022	0.247
120	5328	37.0	8.88	1065.6	0.013	3.19	121	3946	179982	0.023	0.263
118	5328	37.0	8.88	1047.8	0.013	3.14	124	4191	179982	0.023	0.279
116	5328	37.0	8.88	1030.1	0.013	3.08	127	4443	179982	0.024	0.296
114	5328	37.0	8.88	1012.3	0.012	3.03	130	4701	179982	0.024	0.313
112	5328	37.0	8.88	994.6	0.012	2.98	133	4964	179982	0.025	0.331
110	5328	37.0	8.88	976.8	0.012	2.92	136	5234	179982	0.026	0.349
108	5328	37.0	8.88	959.0	0.012	2.87	139	5510	179982	0.026	0.367
106	5328	37.0	8.88	941.3	0.012	2.82	142	5791	179982	0.027	0.386
104	5328	37.0	8.88	923.5	0.011	2.76	145	6078	179982	0.027	0.405
102	5328	37.0	8.88	905.8	0.011	2.71	147	6370	179982	0.028	0.425
100	5328	37.0	8.88	888.0	0.011	2.66	150	6668	179982	0.028	0.445
98	5328	37.0	8.88	870.2	0.011	2.60	153	6970	179982	0.029	0.465
96	5328	37.0	8.88	852.5	0.010	2.55	155	7279	179982	0.029	0.485
94	5328	37.0	8.88	834.7	0.010	2.50	158	7592	179982	0.030	0.506
92	5328	37.0	8.88	817.0	0.010	2.44	160	7910	179982	0.030	0.527
90	5328	37.0	8.88	799.2	0.010	2.39	163	8233	179982	0.031	0.549
88	5328	37.0	8.88	781.4	0.010	2.34	165	8560	179982	0.031	0.571
86	5328	37.0	8.88	763.7	0.009	2.29	167	8892	179982	0.031	0.593
84	5328	37.0	8.88	745.9	0.009	2.23	169	9229	179982	0.032	0.615
82	5328	37.0	8.88	728.2	0.009	2.18	172	9570	192479	0.032	0.597
80	5734	39.8	9.56	764.6	0.009	2.29	174	9916	204977	0.030	0.581
78	6141	42.6	10.23	798.3	0.010	2.39	176	10266	217474	0.029	0.566
76	6547	45.5	10.91	829.3	0.010	2.48	179	10621	229972	0.027	0.554
74	6954	48.3	11.59	857.6	0.011	2.57	181	10982	242469	0.026	0.543
72	7360	51.1	12.27	883.2	0.011	2.64	184	11347	242469	0.025	0.562
70	7360	51.1	12.27	858.7	0.011	2.57	187	11718	242469	0.025	0.580
68	7360	51.1	12.27	834.1	0.010	2.50	189	12093	242469	0.026	0.599
66	7360	51.1	12.27	809.6	0.010	2.42	192	12474	242469	0.026	0.617

frame forces_180ft

SEISMIC EFFECTS

TG 20

64	7360	51.1	12.27	785.1	0.010	2.35	194	12859	242469	0.026	0.636
62	7360	51.1	12.27	760.5	0.009	2.28	196	13249	260460	0.027	0.610
60	7792	54.1	12.99	779.2	0.010	2.33	198	13644	278451	0.025	0.588
58	8224	57.1	13.71	795.0	0.010	2.38	201	14043	296442	0.024	0.568
56	8656	60.1	14.43	807.9	0.010	2.42	203	14447	314433	0.023	0.551
54	9088	63.1	15.15	817.9	0.010	2.45	206	14856	332424	0.023	0.536
52	9520	66.1	15.87	825.1	0.010	2.47	208	15270	332424	0.022	0.551
50	9520	66.1	15.87	793.3	0.010	2.37	211	15689	332424	0.022	0.566
48	9520	66.1	15.87	761.6	0.009	2.28	213	16113	332424	0.022	0.582
46	9520	66.1	15.87	729.9	0.009	2.18	215	16540	332424	0.023	0.597
44	9520	66.1	15.87	698.1	0.009	2.09	217	16973	332424	0.023	0.613
42	9520	66.1	15.87	666.4	0.008	1.99	219	17409	350041	0.023	0.597
40	9978	69.3	16.63	665.2	0.008	1.99	221	17849	367658	0.022	0.583
38	10435	72.5	17.39	660.9	0.008	1.98	223	18293	385275	0.021	0.570
36	10893	75.6	18.15	653.6	0.008	1.96	225	18741	402892	0.021	0.558
34	11350	78.8	18.92	643.2	0.008	1.92	227	19193	420509	0.020	0.548
32	11808	82.0	19.68	629.8	0.008	1.88	229	19649	420509	0.019	0.561
30	11808	82.0	19.68	590.4	0.007	1.77	231	20109	420509	0.020	0.574
28	11808	82.0	19.68	551.0	0.007	1.65	232	20572	420509	0.020	0.587
26	11808	82.0	19.68	511.7	0.006	1.53	234	21038	420509	0.020	0.600
24	11808	82.0	19.68	472.3	0.006	1.41	235	21507	420509	0.020	0.614
22	11808	82.0	19.68	433.0	0.005	1.30	237	21978	420509	0.020	0.627
20	11808	82.0	19.68	393.6	0.005	1.18	238	22452	420509	0.020	0.641
18	11808	82.0	19.68	354.2	0.004	1.06	239	22929	420509	0.020	0.654
16	11808	82.0	19.68	314.9	0.004	0.94	240	23407	420509	0.020	0.668
14	11808	82.0	19.68	275.5	0.003	0.82	241	23888	420509	0.020	0.682
12	11808	82.0	19.68	236.2	0.003	0.71	241	24369	420509	0.020	0.695
10	11808	82.0	19.68	196.8	0.002	0.59	242	24852	420509	0.020	0.709
8	11808	82.0	19.68	157.4	0.002	0.47	242	25336	420509	0.021	0.723
6	11808	82.0	19.68	118.1	0.001	0.35	243	25821	420509	0.021	0.737
4	11808	82.0	19.68	78.7	0.001	0.24	243	26307	420509	0.021	0.751
2	11808	82.0	19.68	39.4	0.000	0.12	243	26793	420509	0.021	0.765
0	11808	82.0	9.84	4.92	0.000	0.01	243	27279	420509	0.021	0.778

1102.73 81198.7 243

CoG = 73.6 ft

ap = 2.5

(ASCE 41-06 Table 11-2)

Rp = 2.5

Ip = 1.0

h = 180.0 ft

Wp = 1102.7 kips

SDS = 0.303

Fp = 243 kips

(ASCE 41-06 Eq. 11-4)

frame forces_180ft

ULTIMATE STRESS

P. 21

Height	WIND COMBO						SEISMIC COMBO					
	1.0°fa	1.0°fv	1.0°fb	Fv	Ft	Fc	0.9°fa	1.0°fv	1.0°fb	Fv	Ft	Fc
180	0.001	0.000	0.000	0.000	-0.001	-0.001	0.001	0.000	0.000	0.000	-0.001	-0.001
178	0.003	0.000	0.000	0.000	-0.002	-0.003	0.002	0.001	0.001	0.001	-0.002	-0.003
176	0.004	0.000	0.000	0.000	-0.004	-0.005	0.004	0.002	0.002	0.002	-0.002	-0.006
174	0.006	0.001	0.001	0.001	-0.005	-0.007	0.005	0.003	0.004	0.003	-0.001	-0.009
172	0.008	0.001	0.001	0.001	-0.006	-0.009	0.007	0.004	0.006	0.004	0.000	-0.013
170	0.009	0.001	0.002	0.001	-0.007	-0.011	0.008	0.005	0.009	0.005	0.001	-0.018
168	0.011	0.001	0.002	0.001	-0.008	-0.013	0.010	0.006	0.013	0.006	0.003	-0.023
166	0.013	0.001	0.003	0.001	-0.009	-0.016	0.011	0.006	0.017	0.006	0.006	-0.029
164	0.014	0.001	0.004	0.001	-0.010	-0.018	0.013	0.007	0.022	0.007	0.009	-0.035
162	0.016	0.001	0.005	0.001	-0.011	-0.021	0.014	0.008	0.028	0.008	0.013	-0.042
160	0.018	0.002	0.006	0.002	-0.011	-0.024	0.016	0.009	0.034	0.009	0.018	-0.049
158	0.019	0.002	0.007	0.002	-0.012	-0.027	0.017	0.010	0.040	0.010	0.023	-0.058
156	0.021	0.002	0.009	0.002	-0.012	-0.030	0.019	0.010	0.047	0.010	0.029	-0.066
154	0.023	0.002	0.010	0.002	-0.012	-0.033	0.020	0.011	0.055	0.011	0.035	-0.075
152	0.024	0.002	0.012	0.002	-0.012	-0.036	0.022	0.012	0.063	0.012	0.042	-0.085
150	0.026	0.002	0.013	0.002	-0.012	-0.039	0.023	0.013	0.072	0.013	0.049	-0.095
148	0.028	0.003	0.015	0.003	-0.012	-0.043	0.025	0.013	0.081	0.013	0.057	-0.106
146	0.029	0.003	0.017	0.003	-0.012	-0.046	0.026	0.014	0.091	0.014	0.065	-0.118
144	0.031	0.003	0.019	0.003	-0.012	-0.050	0.028	0.015	0.102	0.015	0.074	-0.129
142	0.033	0.003	0.021	0.003	-0.011	-0.054	0.029	0.016	0.112	0.016	0.083	-0.142
140	0.034	0.003	0.023	0.003	-0.011	-0.058	0.031	0.016	0.124	0.016	0.093	-0.155
138	0.036	0.003	0.026	0.003	-0.010	-0.062	0.032	0.017	0.136	0.017	0.103	-0.168
136	0.038	0.003	0.028	0.003	-0.009	-0.066	0.034	0.018	0.148	0.018	0.114	-0.182
134	0.039	0.004	0.031	0.004	-0.009	-0.070	0.035	0.018	0.161	0.018	0.125	-0.196
132	0.041	0.004	0.033	0.004	-0.008	-0.074	0.037	0.019	0.174	0.019	0.137	-0.211
130	0.043	0.004	0.036	0.004	-0.006	-0.079	0.038	0.020	0.188	0.020	0.149	-0.226
128	0.044	0.004	0.039	0.004	-0.005	-0.083	0.040	0.020	0.202	0.020	0.162	-0.242
126	0.046	0.004	0.042	0.004	-0.004	-0.088	0.041	0.021	0.217	0.021	0.175	-0.258
124	0.048	0.004	0.045	0.004	-0.003	-0.092	0.043	0.022	0.232	0.022	0.189	-0.274
122	0.049	0.005	0.048	0.005	-0.001	-0.097	0.044	0.022	0.247	0.022	0.203	-0.291
120	0.051	0.005	0.051	0.005	0.000	-0.102	0.046	0.023	0.263	0.023	0.217	-0.309
118	0.053	0.005	0.055	0.005	0.002	-0.107	0.047	0.023	0.279	0.023	0.232	-0.327
116	0.054	0.005	0.058	0.005	0.004	-0.112	0.049	0.024	0.296	0.024	0.247	-0.345
114	0.056	0.005	0.062	0.005	0.006	-0.118	0.050	0.024	0.313	0.024	0.263	-0.364
112	0.058	0.005	0.065	0.005	0.008	-0.123	0.052	0.025	0.331	0.025	0.279	-0.383
110	0.059	0.005	0.069	0.005	0.010	-0.128	0.053	0.026	0.349	0.026	0.296	-0.402
108	0.061	0.006	0.073	0.006	0.012	-0.134	0.055	0.026	0.367	0.026	0.313	-0.422
106	0.063	0.006	0.077	0.006	0.015	-0.140	0.056	0.027	0.386	0.027	0.330	-0.442
104	0.064	0.006	0.081	0.006	0.017	-0.145	0.058	0.027	0.405	0.027	0.347	-0.463
102	0.066	0.006	0.085	0.006	0.019	-0.151	0.059	0.028	0.425	0.028	0.365	-0.484
100	0.068	0.006	0.090	0.006	0.022	-0.157	0.061	0.028	0.445	0.028	0.384	-0.505
98	0.069	0.006	0.094	0.006	0.025	-0.163	0.062	0.029	0.465	0.029	0.402	-0.527
96	0.071	0.006	0.098	0.006	0.028	-0.169	0.064	0.029	0.485	0.029	0.422	-0.549
94	0.073	0.007	0.103	0.007	0.031	-0.176	0.065	0.030	0.506	0.030	0.441	-0.571
92	0.074	0.007	0.108	0.007	0.034	-0.182	0.067	0.030	0.527	0.030	0.461	-0.594
90	0.076	0.007	0.113	0.007	0.037	-0.188	0.068	0.031	0.549	0.031	0.481	-0.617
88	0.078	0.007	0.117	0.007	0.040	-0.195	0.070	0.031	0.571	0.031	0.501	-0.640
86	0.079	0.007	0.122	0.007	0.043	-0.202	0.071	0.031	0.593	0.031	0.522	-0.664
84	0.081	0.007	0.127	0.007	0.047	-0.208	0.073	0.032	0.615	0.032	0.543	-0.688
82	0.082	0.007	0.124	0.007	0.042	-0.207	0.074	0.032	0.597	0.032	0.522	-0.671
80	0.078	0.006	0.121	0.006	0.043	-0.199	0.070	0.030	0.581	0.030	0.510	-0.651
78	0.075	0.006	0.119	0.006	0.044	-0.193	0.067	0.029	0.566	0.029	0.499	-0.634
76	0.072	0.006	0.116	0.006	0.045	-0.188	0.065	0.027	0.554	0.027	0.490	-0.619
74	0.069	0.006	0.115	0.006	0.045	-0.184	0.062	0.026	0.543	0.026	0.481	-0.606
72	0.067	0.006	0.119	0.006	0.052	-0.186	0.060	0.025	0.562	0.025	0.501	-0.622
70	0.069	0.006	0.123	0.006	0.054	-0.192	0.062	0.025	0.580	0.025	0.518	-0.642
68	0.070	0.006	0.127	0.006	0.057	-0.198	0.063	0.026	0.599	0.026	0.535	-0.662
66	0.072	0.006	0.132	0.006	0.060	-0.204	0.065	0.026	0.617	0.026	0.552	-0.682
64	0.074	0.006	0.136	0.006	0.062	-0.210	0.066	0.026	0.636	0.026	0.570	-0.703
62	0.075	0.006	0.131	0.006	0.056	-0.206	0.068	0.027	0.610	0.027	0.543	-0.678
60	0.073	0.006	0.127	0.006	0.054	-0.200	0.066	0.025	0.588	0.025	0.522	-0.654
58	0.071	0.006	0.123	0.006	0.052	-0.194	0.064	0.024	0.568	0.024	0.505	-0.632
56	0.069	0.005	0.119	0.005	0.050	-0.188	0.062	0.023	0.551	0.023	0.489	-0.613

frame forces_180ft

ULTIMATE STRESS

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54	0.067	0.005	0.116	0.005	0.049	-0.184	0.061	0.023	0.536	0.023	0.476	-0.597
52	0.066	0.005	0.120	0.005	0.054	-0.186	0.059	0.022	0.551	0.022	0.492	-0.611
50	0.068	0.005	0.124	0.005	0.056	-0.191	0.061	0.022	0.566	0.022	0.506	-0.627
48	0.069	0.005	0.127	0.005	0.058	-0.197	0.062	0.022	0.582	0.022	0.519	-0.644
46	0.071	0.005	0.131	0.005	0.060	-0.202	0.064	0.023	0.597	0.023	0.533	-0.651
44	0.073	0.006	0.135	0.006	0.062	-0.207	0.065	0.023	0.613	0.023	0.547	-0.678
42	0.074	0.005	0.132	0.005	0.058	-0.206	0.067	0.023	0.587	0.023	0.530	-0.664
40	0.073	0.005	0.129	0.005	0.056	-0.201	0.065	0.022	0.583	0.022	0.517	-0.648
38	0.071	0.005	0.126	0.005	0.055	-0.197	0.064	0.021	0.570	0.021	0.506	-0.634
36	0.070	0.005	0.124	0.005	0.055	-0.194	0.063	0.021	0.558	0.021	0.495	-0.621
34	0.069	0.005	0.122	0.005	0.054	-0.191	0.062	0.020	0.548	0.020	0.486	-0.609
32	0.068	0.005	0.125	0.005	0.058	-0.193	0.061	0.019	0.561	0.019	0.500	-0.622
30	0.069	0.005	0.129	0.005	0.060	-0.198	0.062	0.020	0.574	0.020	0.512	-0.636
28	0.071	0.005	0.132	0.005	0.061	-0.203	0.064	0.020	0.587	0.020	0.523	-0.651
26	0.073	0.005	0.135	0.005	0.063	-0.208	0.065	0.020	0.600	0.020	0.535	-0.666
24	0.074	0.005	0.139	0.005	0.065	-0.213	0.067	0.020	0.614	0.020	0.547	-0.681
22	0.076	0.005	0.142	0.005	0.066	-0.218	0.068	0.020	0.627	0.020	0.559	-0.695
20	0.078	0.005	0.146	0.005	0.068	-0.223	0.070	0.020	0.641	0.020	0.571	-0.711
18	0.079	0.005	0.149	0.005	0.070	-0.228	0.071	0.020	0.654	0.020	0.583	-0.726
16	0.081	0.005	0.153	0.005	0.072	-0.234	0.073	0.020	0.668	0.020	0.595	-0.741
14	0.083	0.005	0.156	0.005	0.074	-0.239	0.074	0.020	0.682	0.020	0.607	-0.756
12	0.084	0.005	0.160	0.005	0.076	-0.244	0.076	0.020	0.695	0.020	0.620	-0.771
10	0.086	0.005	0.164	0.005	0.078	-0.249	0.077	0.020	0.709	0.020	0.632	-0.787
8	0.088	0.005	0.167	0.005	0.080	-0.255	0.079	0.021	0.723	0.021	0.644	-0.802
6	0.089	0.006	0.171	0.006	0.082	-0.260	0.080	0.021	0.737	0.021	0.657	-0.817
4	0.091	0.006	0.175	0.006	0.084	-0.266	0.082	0.021	0.751	0.021	0.669	-0.833
2	0.093	0.006	0.179	0.006	0.086	-0.271	0.083	0.021	0.765	0.021	0.681	-0.848
0	0.093	0.006	0.182	0.006	0.089	-0.276	0.084	0.021	0.778	0.021	0.694	-0.862

*Positive values indicate tension and negative values indicate compression

SAP2000

7/15/11 11:12:38

$h=100'$



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Table: Modal Periods And Frequencies

OutputCase	StepType	StepNum	Period Sec	Frequency Cyc/sec	CircFreq rad/sec	Eigenvalue rad ² /sec ²
MODAL	Mode	1.000000	0.616113	1.6231E+00	1.0198E+01	1.0400E+02
MODAL	Mode	2.000000	0.616113	1.6231E+00	1.0198E+01	1.0400E+02
MODAL	Mode	3.000000	0.138704	7.2096E+00	4.5299E+01	2.0520E+03
MODAL	Mode	4.000000	0.138704	7.2096E+00	4.5299E+01	2.0520E+03
MODAL	Mode	5.000000	0.063299	1.5798E+01	9.9263E+01	9.8531E+03
MODAL	Mode	6.000000	0.059689	1.6753E+01	1.0527E+02	1.1081E+04
MODAL	Mode	7.000000	0.059689	1.6753E+01	1.0527E+02	1.1081E+04
MODAL	Mode	8.000000	0.035125	2.8469E+01	1.7888E+02	3.1997E+04
MODAL	Mode	9.000000	0.035125	2.8469E+01	1.7888E+02	3.1997E+04
MODAL	Mode	10.000000	0.025517	3.9190E+01	2.4624E+02	6.0634E+04
MODAL	Mode	11.000000	0.024138	4.1428E+01	2.6030E+02	6.7757E+04
MODAL	Mode	12.000000	0.024138	4.1428E+01	2.6030E+02	6.7757E+04

$$T = 0.62 \text{ s}$$

$\zeta = 1.62 F_2$ is rigid structure

frame forces_100ft

AXIAL EFFECTS

Ht	Area (in^2)	Area (ft^2)	Weight	h^*W	P (k)	Fa (ksi)
100	5328	37.0	4.44	444.0	4.44	0.001
98	5328	37.0	8.88	870.2	13.32	0.003
96	5328	37.0	8.88	852.5	22.20	0.004
94	5328	37.0	8.88	834.7	31.08	0.006
92	5328	37.0	8.88	817.0	39.96	0.008
90	5328	37.0	8.88	799.2	48.84	0.009
88	5328	37.0	8.88	781.4	57.72	0.011
86	5328	37.0	8.88	763.7	66.60	0.013
84	5328	37.0	8.88	745.9	75.48	0.014
82	5328	37.0	8.88	728.2	84.36	0.016
80	5734	39.8	9.56	764.6	93.92	0.016
78	6141	42.6	10.23	798.3	104.15	0.017
76	6547	45.5	10.91	829.3	115.06	0.018
74	6954	48.3	11.59	857.6	126.65	0.018
72	7360	51.1	12.27	883.2	138.92	0.019
70	7360	51.1	12.27	858.7	151.19	0.021
68	7360	51.1	12.27	834.1	163.45	0.022
66	7360	51.1	12.27	809.6	175.72	0.024
64	7360	51.1	12.27	785.1	187.99	0.026
62	7360	51.1	12.27	760.5	200.25	0.027
60	7792	54.1	12.99	779.2	213.24	0.027
58	8224	57.1	13.71	795.0	226.95	0.028
56	8656	60.1	14.43	807.9	241.37	0.028
54	9088	63.1	15.15	817.9	256.52	0.028
52	9520	66.1	15.87	825.1	272.39	0.029
50	9520	66.1	15.87	793.3	288.25	0.030
48	9520	66.1	15.87	761.6	304.12	0.032
46	9520	66.1	15.87	729.9	319.99	0.034
44	9520	66.1	15.87	698.1	335.85	0.035
42	9520	66.1	15.87	666.4	351.72	0.037
40	9978	69.3	16.63	665.2	368.35	0.037
38	10435	72.5	17.39	660.9	385.74	0.037
36	10893	75.6	18.15	653.6	403.90	0.037
34	11350	78.8	18.92	643.2	422.81	0.037
32	11808	82.0	19.68	629.8	442.49	0.037
30	11808	82.0	19.68	590.4	462.17	0.039
28	11808	82.0	19.68	551.0	481.85	0.041
26	11808	82.0	19.68	511.7	501.53	0.042
24	11808	82.0	19.68	472.3	521.21	0.044
22	11808	82.0	19.68	433.0	540.89	0.046
20	11808	82.0	19.68	393.6	560.57	0.047
18	11808	82.0	19.68	354.2	580.25	0.049
16	11808	82.0	19.68	314.9	599.93	0.051
14	11808	82.0	19.68	275.5	619.61	0.052
12	11808	82.0	19.68	236.2	639.29	0.054
10	11808	82.0	19.68	196.8	658.97	0.056
8	11808	82.0	19.68	157.4	678.65	0.057
6	11808	82.0	19.68	118.1	698.33	0.059
4	11808	82.0	19.68	78.7	718.01	0.061
2	11808	82.0	19.68	39.4	737.69	0.062
0	11808	82.0	9.84	4.92	747.53	0.063

747.53 31472.9

CoG = 42.1 ft

frame forces 100ft

WIND EFFECTS

V 93 mph
 Kd 0.9
 h 100 ft

Ht. (ft)	Width	Aproj (ft^2)	A°h	Kz	qz	F (lbs)	V (k)	M (k-ft)	Av	5x	fv	fb
100	10.25	20.50	2050.00	1.27	25.22	610.856	0.61	0.0	5328	179982	0.000	0.000
98	10.25	20.50	2009.00	1.26	25.11	608.2634	1.22	1.8	5328	179982	0.000	0.000
96	10.25	20.50	1968.00	1.25	25.00	605.6288	1.82	4.9	5328	179982	0.000	0.000
94	10.25	20.50	1927.00	1.25	24.89	602.9504	2.43	9.1	5328	179982	0.000	0.001
92	10.25	20.50	1886.00	1.24	24.78	600.2266	3.03	14.6	5328	179982	0.001	0.001
90	10.25	20.50	1845.00	1.24	24.67	597.4557	3.63	21.2	5328	179982	0.001	0.001
88	10.25	20.50	1804.00	1.23	24.55	594.6357	4.22	29.1	5328	179982	0.001	0.002
86	10.25	20.50	1763.00	1.23	24.43	591.7647	4.81	38.1	5328	179982	0.001	0.003
84	10.25	20.50	1722.00	1.22	24.31	588.8405	5.40	48.3	5328	179982	0.001	0.003
82	10.25	20.50	1681.00	1.21	24.19	585.8608	5.99	59.7	5734	192479	0.001	0.004
80	10.38	20.77	1661.33	1.21	24.06	590.4049	6.58	72.3	6141	204977	0.001	0.004
78	10.52	21.03	1640.60	1.20	23.94	594.8079	7.17	86.0	6547	217474	0.001	0.005
76	10.65	21.30	1618.80	1.19	23.80	599.0644	7.77	101.0	6954	229972	0.001	0.005
74	10.78	21.57	1595.94	1.19	23.67	603.1689	8.37	117.1	7360	242469	0.001	0.006
72	10.92	21.83	1572.00	1.18	23.54	607.1152	8.98	134.5	7360	242469	0.001	0.007
70	10.92	21.83	1528.34	1.17	23.40	603.5252	9.58	153.0	7360	242469	0.001	0.008
68	10.92	21.83	1484.67	1.17	23.25	599.8533	10.18	172.8	7360	242469	0.001	0.009
66	10.92	21.83	1441.00	1.16	23.11	596.0952	10.78	193.8	7360	242469	0.001	0.010
64	10.92	21.83	1397.34	1.15	22.96	592.246	11.37	215.9	7360	242469	0.002	0.011
62	10.92	22.10	1370.12	1.14	22.81	595.4497	11.97	239.3	7792	260460	0.002	0.011
60	11.05	22.36	1341.84	1.14	22.65	598.4533	12.57	263.8	8224	278451	0.002	0.011
58	11.18	22.63	1312.50	1.13	22.49	601.2466	13.17	289.5	8656	296442	0.002	0.012
56	11.31	22.89	1282.10	1.12	22.32	603.8187	13.77	316.5	9088	314433	0.002	0.012
54	11.45	23.16	1250.64	1.11	22.15	606.1574	14.38	344.6	9520	332424	0.002	0.012
52	11.58	23.17	1204.63	1.10	21.98	601.5161	14.98	374.0	9520	332424	0.002	0.013
50	11.58	23.17	1158.30	1.09	21.80	596.5699	15.58	404.5	9520	332424	0.002	0.015
48	11.58	23.17	1111.97	1.08	21.61	591.4648	16.17	436.3	9520	332424	0.002	0.016
46	11.58	23.17	1065.64	1.07	21.42	586.189	16.75	469.2	9520	332424	0.002	0.017
44	11.58	23.17	1019.30	1.06	21.22	580.7289	17.33	503.3	9520	332424	0.002	0.018
42	11.58	23.17	972.97	1.05	21.01	575.0692	17.91	538.5	9978	350041	0.002	0.018
40	11.72	23.43	937.31	1.04	20.80	575.7479	18.49	574.9	10435	367658	0.002	0.019
38	11.85	23.70	900.58	1.03	20.57	576.049	19.06	612.5	10893	385275	0.002	0.019
36	11.98	23.97	862.79	1.02	20.34	575.9407	19.64	651.2	11350	402892	0.002	0.019
34	12.12	24.23	823.93	1.01	20.10	575.3866	20.21	691.0	11808	420509	0.002	0.020
32	12.25	24.50	784.00	1.00	19.84	574.3441	20.79	732.0	11808	420509	0.002	0.021
30	12.25	24.50	735.00	0.98	19.57	566.5932	21.35	774.2	11808	420509	0.002	0.022
28	12.25	24.50	686.00	0.97	19.29	558.423	21.91	817.4	11808	420509	0.002	0.023
26	12.25	24.50	637.00	0.95	18.99	549.7783	22.46	861.8	11808	420509	0.002	0.025
24	12.25	24.50	588.00	0.94	18.68	540.5915	23.00	907.3	11808	420509	0.002	0.026
22	12.25	24.50	539.00	0.92	18.34	530.779	23.53	953.8	11808	420509	0.002	0.027
20	12.25	24.50	490.00	0.90	17.97	520.2349	24.05	1001.4	11808	420509	0.002	0.029
18	12.25	24.50	441.00	0.88	17.58	508.8225	24.56	1050.0	11808	420509	0.002	0.030
16	12.25	24.50	392.00	0.86	17.15	496.3607	25.06	1099.6	11808	420509	0.002	0.031
14	12.25	24.50	343.00	0.85	16.92	489.6622	25.55	1150.2	11808	420509	0.002	0.033
12	12.25	24.50	294.00	0.85	16.92	489.6622	26.04	1201.8	11808	420509	0.002	0.034
10	12.25	24.50	245.00	0.85	16.92	489.6622	26.53	1254.4	11808	420509	0.002	0.036
8	12.25	24.50	196.00	0.85	16.92	489.6622	27.02	1307.9	11808	420509	0.002	0.037
6	12.25	24.50	147.00	0.85	16.92	489.6622	27.51	1362.4	11808	420509	0.002	0.039
4	12.25	24.50	98.00	0.85	16.92	489.6622	28.00	1417.9	11808	420509	0.002	0.040
2	12.25	24.50	49.00	0.85	16.92	489.6622	28.49	1474.4	11808	420509	0.002	0.042
0	12.25	12.25	6.13	0.85	16.92	244.8311	28.73	1531.6	11808	420509	0.002	0.044

$$F = 29.38 \text{ kips} \quad F = q_i * C_i * G * A_i \quad (\text{ASCE 7-05 Eq. 6-28})$$

$$A_1 = -1151 \quad R^2$$

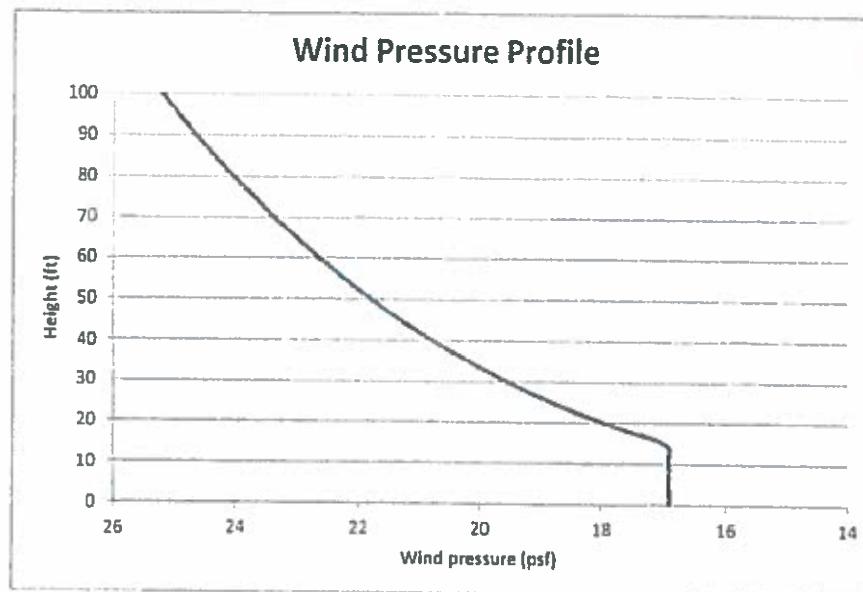
CoA = 48.6 ft

$q_{CSA} = 21.61 \text{ psf}$ $C_t = 1.39$ $n_1 = 1.623$ $G_f = 0.85$

(ASCE 7-05 Fig. 6-21)

(Rigid per ASCE 7-05 6.2)

(ASCE 7-05 6.5.8.1)



frame forces_100ft

SEISMIC EFFECTS

Ht	A (in^2)	A(ft^2)	Weight	h*W	Σh^*w	Fx (k)	V (k)	M (k-ft)	S (in^3)	Fv (ksi)	Fb (ksi)
100	5328	37.0	4.44	444.0	0.014	2.35	2	0	179982	0.000	0.000
98	5328	37.0	8.88	870.2	0.028	4.61	7	9	179982	0.001	0.001
96	5328	37.0	8.88	852.5	0.027	4.52	11	28	179982	0.002	0.002
94	5328	37.0	8.88	834.7	0.027	4.43	16	55	179982	0.003	0.004
92	5328	37.0	8.88	817.0	0.026	4.33	20	91	179982	0.004	0.006
90	5328	37.0	8.88	799.2	0.025	4.24	24	136	179982	0.005	0.009
88	5328	37.0	8.88	781.4	0.025	4.14	29	189	179982	0.005	0.013
86	5328	37.0	8.88	763.7	0.024	4.05	33	251	179982	0.006	0.017
84	5328	37.0	8.88	745.9	0.024	3.96	37	320	179982	0.007	0.021
82	5328	37.0	8.88	728.2	0.023	3.86	40	397	192479	0.008	0.025
80	5734	39.8	9.56	764.6	0.024	4.05	45	482	204977	0.008	0.028
78	6141	42.6	10.23	798.3	0.025	4.23	49	575	217474	0.008	0.032
76	6547	45.5	10.91	829.3	0.026	4.40	53	677	229972	0.008	0.035
74	6954	48.3	11.59	857.6	0.027	4.55	58	788	242469	0.008	0.039
72	7360	51.1	12.27	883.2	0.028	4.68	62	908	242469	0.008	0.045
70	7360	51.1	12.27	858.7	0.027	4.55	67	1038	242469	0.009	0.051
68	7360	51.1	12.27	834.1	0.027	4.42	71	1176	242469	0.010	0.058
66	7360	51.1	12.27	809.6	0.026	4.29	76	1323	242469	0.010	0.065
64	7360	51.1	12.27	785.1	0.025	4.16	80	1479	242469	0.011	0.073
62	7360	51.1	12.27	760.5	0.024	4.03	84	1642	260460	0.011	0.076
60	7792	54.1	12.99	779.2	0.025	4.13	88	1814	278451	0.011	0.078
58	8224	57.1	13.71	795.0	0.025	4.22	92	1995	296442	0.011	0.081
56	8656	60.1	14.43	807.9	0.026	4.28	97	2183	314433	0.011	0.083
54	9088	63.1	15.15	817.9	0.026	4.34	101	2381	332424	0.011	0.086
52	9520	66.1	15.87	825.1	0.026	4.38	105	2587	332424	0.011	0.093
50	9520	66.1	15.87	793.3	0.025	4.21	109	2801	332424	0.011	0.101
48	9520	66.1	15.87	761.6	0.024	4.04	113	3024	332424	0.012	0.109
46	9520	66.1	15.87	729.9	0.023	3.87	117	3255	332424	0.012	0.118
44	9520	66.1	15.87	698.1	0.022	3.70	121	3493	332424	0.013	0.126
42	9520	66.1	15.87	666.4	0.021	3.53	125	3739	350041	0.013	0.128
40	9978	69.3	16.63	665.2	0.021	3.53	128	3992	367658	0.013	0.130
38	10435	72.5	17.39	660.9	0.021	3.50	132	4251	385275	0.013	0.132
36	10893	75.6	18.15	653.6	0.021	3.47	135	4518	402892	0.012	0.135
34	11350	78.8	18.92	643.2	0.020	3.41	138	4792	420509	0.012	0.137
32	11808	82.0	19.68	629.8	0.020	3.34	142	5072	420509	0.012	0.145
30	11808	82.0	19.68	590.4	0.019	3.13	145	5359	420509	0.012	0.153
28	11808	82.0	19.68	551.0	0.018	2.92	148	5651	420509	0.013	0.161
26	11808	82.0	19.68	511.7	0.016	2.71	151	5950	420509	0.013	0.170
24	11808	82.0	19.68	472.3	0.015	2.50	153	6254	420509	0.013	0.178
22	11808	82.0	19.68	433.0	0.014	2.30	155	6562	420509	0.013	0.187
20	11808	82.0	19.68	393.6	0.013	2.09	157	6875	420509	0.013	0.196
18	11808	82.0	19.68	354.2	0.011	1.88	159	7192	420509	0.013	0.205
16	11808	82.0	19.68	314.9	0.010	1.67	161	7512	420509	0.014	0.214
14	11808	82.0	19.68	275.5	0.009	1.46	162	7836	420509	0.014	0.224
12	11808	82.0	19.68	236.2	0.008	1.25	164	8162	420509	0.014	0.233
10	11808	82.0	19.68	196.8	0.006	1.04	165	8490	420509	0.014	0.242
8	11808	82.0	19.68	157.4	0.005	0.83	166	8821	420509	0.014	0.252
6	11808	82.0	19.68	118.1	0.004	0.63	166	9153	420509	0.014	0.261
4	11808	82.0	19.68	78.7	0.003	0.42	167	9486	420509	0.014	0.271
2	11808	82.0	19.68	39.4	0.001	0.21	167	9819	420509	0.014	0.280
0	11808	82.0	9.84	4.92	0.000	0.03	167	10153	420509	0.014	0.290

747.53 31472.9

167

CoG = 42.1 ft

ap = 2.5

Rp = 2.5

Ip = 1.0

h = 100.0 ft

Wp = 747.5 kips

SDS = 0.303

Fp = 167 kips

(ASCE 41-06 Table 11-2)

(ASCE 41-06 Eq. 11-4)

frame forces_100ft

ULTIMATE STRESS

Height	WIND						SEISMIC					
	1.0*fa	1.0*fv	1.0*fb	Fv	Ft	Fc	0.9*fa	1.0*fv	1.0*fb	Fv	Ft	Fc
100	0.001	0.000	0.000	0.000	-0.001	-0.001	0.001	0.000	0.000	0.000	-0.001	-0.001
98	0.003	0.000	0.000	0.000	-0.002	-0.003	0.002	0.001	0.001	0.001	-0.002	-0.003
96	0.004	0.000	0.000	0.000	-0.004	-0.004	0.004	0.002	0.002	0.002	-0.002	-0.006
94	0.006	0.000	0.001	0.000	-0.005	-0.006	0.005	0.003	0.004	0.003	-0.002	-0.009
92	0.008	0.001	0.001	0.001	-0.007	-0.008	0.007	0.004	0.006	0.004	-0.001	-0.013
90	0.009	0.001	0.001	0.001	-0.008	-0.011	0.008	0.005	0.009	0.005	0.001	-0.017
88	0.011	0.001	0.002	0.001	-0.009	-0.013	0.010	0.005	0.013	0.005	0.003	-0.022
86	0.013	0.001	0.003	0.001	-0.010	-0.015	0.011	0.006	0.017	0.006	0.005	-0.028
84	0.014	0.001	0.003	0.001	-0.011	-0.017	0.013	0.007	0.021	0.007	0.009	-0.034
82	0.016	0.001	0.004	0.001	-0.012	-0.020	0.014	0.008	0.025	0.008	0.010	-0.039
80	0.016	0.001	0.004	0.001	-0.012	-0.021	0.015	0.008	0.028	0.008	0.013	-0.043
78	0.017	0.001	0.005	0.001	-0.012	-0.022	0.015	0.008	0.032	0.008	0.016	-0.047
76	0.018	0.001	0.005	0.001	-0.012	-0.023	0.016	0.008	0.035	0.008	0.020	-0.051
74	0.018	0.001	0.006	0.001	-0.012	-0.024	0.016	0.008	0.039	0.008	0.023	-0.055
72	0.019	0.001	0.007	0.001	-0.012	-0.026	0.017	0.008	0.045	0.008	0.028	-0.062
70	0.021	0.001	0.008	0.001	-0.013	-0.028	0.018	0.009	0.051	0.009	0.033	-0.070
68	0.022	0.001	0.009	0.001	-0.014	-0.031	0.020	0.010	0.058	0.010	0.038	-0.078
66	0.024	0.001	0.010	0.001	-0.014	-0.033	0.021	0.010	0.065	0.010	0.044	-0.087
64	0.026	0.002	0.011	0.002	-0.015	-0.036	0.023	0.011	0.073	0.011	0.050	-0.096
62	0.027	0.002	0.011	0.002	-0.016	-0.038	0.024	0.011	0.076	0.011	0.051	-0.100
60	0.027	0.002	0.011	0.002	-0.016	-0.039	0.025	0.011	0.078	0.011	0.054	-0.103
58	0.028	0.002	0.012	0.002	-0.016	-0.039	0.025	0.011	0.081	0.011	0.056	-0.106
56	0.028	0.002	0.012	0.002	-0.016	-0.040	0.025	0.011	0.083	0.011	0.058	-0.108
54	0.028	0.002	0.012	0.002	-0.016	-0.041	0.025	0.011	0.086	0.011	0.061	-0.111
52	0.029	0.002	0.013	0.002	-0.015	-0.042	0.026	0.011	0.093	0.011	0.068	-0.119
50	0.030	0.002	0.015	0.002	-0.016	-0.045	0.027	0.011	0.101	0.011	0.074	-0.128
48	0.032	0.002	0.016	0.002	-0.016	-0.048	0.029	0.012	0.109	0.012	0.080	-0.138
46	0.034	0.002	0.017	0.002	-0.017	-0.051	0.030	0.012	0.118	0.012	0.087	-0.148
44	0.035	0.002	0.018	0.002	-0.017	-0.053	0.032	0.013	0.126	0.013	0.094	-0.158
42	0.037	0.002	0.018	0.002	-0.018	-0.055	0.033	0.013	0.128	0.013	0.095	-0.161
40	0.037	0.002	0.019	0.002	-0.018	-0.056	0.033	0.013	0.130	0.013	0.097	-0.164
38	0.037	0.002	0.019	0.002	-0.018	-0.056	0.033	0.013	0.132	0.013	0.099	-0.166
36	0.037	0.002	0.019	0.002	-0.018	-0.056	0.033	0.012	0.135	0.012	0.101	-0.168
34	0.037	0.002	0.020	0.002	-0.018	-0.057	0.034	0.012	0.137	0.012	0.103	-0.170
32	0.037	0.002	0.021	0.002	-0.017	-0.058	0.034	0.012	0.145	0.012	0.111	-0.178
30	0.039	0.002	0.022	0.002	-0.017	-0.061	0.035	0.012	0.153	0.012	0.118	-0.188
28	0.041	0.002	0.023	0.002	-0.017	-0.064	0.037	0.013	0.161	0.013	0.125	-0.198
26	0.042	0.002	0.025	0.002	-0.018	-0.067	0.038	0.013	0.170	0.013	0.132	-0.208
24	0.044	0.002	0.026	0.002	-0.018	-0.070	0.040	0.013	0.178	0.013	0.139	-0.218
22	0.046	0.002	0.027	0.002	-0.019	-0.073	0.041	0.013	0.187	0.013	0.146	-0.228
20	0.047	0.002	0.029	0.002	-0.019	-0.076	0.043	0.013	0.196	0.013	0.153	-0.239
18	0.049	0.002	0.030	0.002	-0.019	-0.079	0.044	0.013	0.205	0.013	0.161	-0.249
16	0.051	0.002	0.031	0.002	-0.019	-0.082	0.046	0.014	0.214	0.014	0.169	-0.260
14	0.052	0.002	0.033	0.002	-0.020	-0.085	0.047	0.014	0.224	0.014	0.176	-0.271
12	0.054	0.002	0.034	0.002	-0.020	-0.088	0.049	0.014	0.233	0.014	0.184	-0.282
10	0.056	0.002	0.036	0.002	-0.020	-0.092	0.050	0.014	0.242	0.014	0.192	-0.293
8	0.057	0.002	0.037	0.002	-0.020	-0.095	0.052	0.014	0.252	0.014	0.200	-0.303
6	0.059	0.002	0.039	0.002	-0.020	-0.098	0.053	0.014	0.261	0.014	0.208	-0.314
4	0.061	0.002	0.040	0.002	-0.020	-0.101	0.055	0.014	0.271	0.014	0.216	-0.325
2	0.062	0.002	0.042	0.002	-0.020	-0.105	0.056	0.014	0.280	0.014	0.224	-0.336
0	0.063	0.002	0.044	0.002	-0.020	-0.107	0.057	0.014	0.290	0.014	0.233	-0.347



WEIDLINGER ASSOCIATES INC
CONSULTING ENGINEERS

- MEETING MINUTES
- FIELD NOTES - DATA
- FIELD LOG
- MEMORANDUM
- DESIGN NOTES

PROJECT	NAE 72-1
CLIENT	NRCC
DATE	03/11
CHIEF ENGINEER	DALE

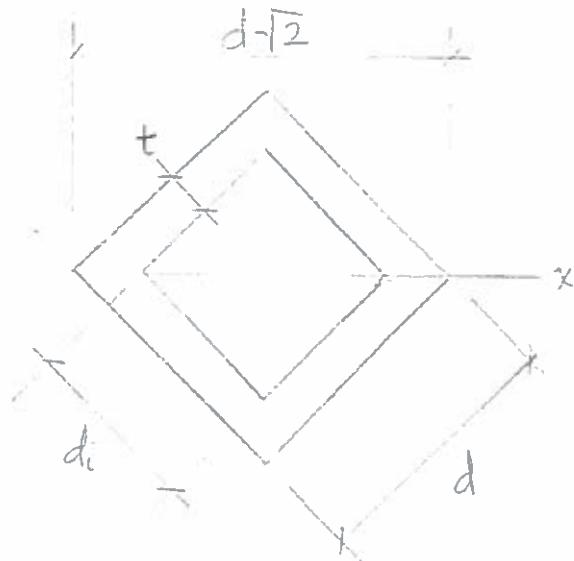
TO	
FROM	
PHONE	703-499-1334
PAGE	1

SUBJECT

SECTION E-2 SECTION = 45°

$$S_y = \frac{d^4 - d_i^4}{6\sqrt{2}t}$$

$$I_x = \frac{d^4 - d_i^4}{12}$$



<u>t</u>	<u>d_i</u>	<u>d</u>	<u>A(m²)</u>	<u>S_y(m³)</u>	<u>I_x(cm⁴)</u>
12	13	99	5382	127267	11068920
16	131	99	7360	178523	16536693
20	139	99	9520	235059	23103453
24	147	99	11808	297245	30907440

ACTION

DISTRIBUTION

Ht	Area (in^2)	Area (ft^2)	Weight	h*W	P (k)	Fa (ksi)
100	5328	37.0	4.44	444.0	4.44	0.001
98	5328	37.0	8.88	870.2	13.32	0.003
96	5328	37.0	8.88	852.5	22.20	0.004
94	5328	37.0	8.88	834.7	31.08	0.006
92	5328	37.0	8.88	817.0	39.96	0.008
90	5328	37.0	8.88	799.2	48.84	0.009
88	5328	37.0	8.88	781.4	57.72	0.011
86	5328	37.0	8.88	763.7	66.60	0.013
84	5328	37.0	8.88	745.9	75.48	0.014
82	5328	37.0	8.88	728.2	84.36	0.016
80	5734	39.8	9.56	764.6	93.92	0.016
78	6141	42.6	10.23	798.3	104.15	0.017
76	6547	45.5	10.91	829.3	115.06	0.018
74	6954	48.3	11.59	857.6	126.65	0.018
72	7360	51.1	12.27	883.2	138.92	0.019
70	7360	51.1	12.27	858.7	151.19	0.021
68	7360	51.1	12.27	834.1	163.45	0.022
66	7360	51.1	12.27	809.6	175.72	0.024
64	7360	51.1	12.27	785.1	187.99	0.026
62	7360	51.1	12.27	760.5	200.25	0.027
60	7792	54.1	12.99	779.2	213.24	0.027
58	8224	57.1	13.71	795.0	226.95	0.028
56	8656	60.1	14.43	807.9	241.37	0.028
54	9088	63.1	15.15	817.9	256.52	0.028
52	9520	66.1	15.87	825.1	272.39	0.029
50	9520	66.1	15.87	793.3	288.25	0.030
48	9520	66.1	15.87	761.6	304.12	0.032
46	9520	66.1	15.87	729.9	319.99	0.034
44	9520	66.1	15.87	698.1	335.85	0.035
42	9520	66.1	15.87	666.4	351.72	0.037
40	9978	69.3	16.63	665.2	368.35	0.037
38	10435	72.5	17.39	660.9	385.74	0.037
36	10893	75.6	18.15	653.6	403.90	0.037
34	11350	78.8	18.92	643.2	422.81	0.037
32	11808	82.0	19.68	629.8	442.49	0.037
30	11808	82.0	19.68	590.4	462.17	0.039
28	11808	82.0	19.68	551.0	481.85	0.041
26	11808	82.0	19.68	511.7	501.53	0.042
24	11808	82.0	19.68	472.3	521.21	0.044
22	11808	82.0	19.68	433.0	540.89	0.046
20	11808	82.0	19.68	393.6	560.57	0.047
18	11808	82.0	19.68	354.2	580.25	0.049
16	11808	82.0	19.68	314.9	599.93	0.051
14	11808	82.0	19.68	275.5	619.61	0.052
12	11808	82.0	19.68	236.2	639.29	0.054
10	11808	82.0	19.68	196.8	658.97	0.056

frame forces_100ft_45deg

AXIAL EFFECTS

8	11808	82.0	19.68	157.4	678.65	0.057
6	11808	82.0	19.68	118.1	698.33	0.059
4	11808	82.0	19.68	78.7	718.01	0.061
2	11808	82.0	19.68	39.4	737.69	0.062
0	11808	82.0	9.84	4.92	747.53	0.063

747.53 31472.9

frame forces_100ft_45deg

WIND EFFECTS

V Kd	93 mph 0.9 (ASCE 7-05 Table 6-4)											
Ht. (ft)	Width	Aproj (ft^2)	A*h	Kz	Qz	F (lbs)	V (k)	M (k ft)	Av	Sx	fv	fb
100	14.50	29.00	2900.00	1.27	25.22	674.5767	0.67	0.0	5328	127267	0.000	0.000
98	14.50	29.00	2842.00	1.26	25.11	671.7137	1.35	2.0	5328	127267	0.000	0.000
96	14.50	29.00	2784.00	1.25	25.00	668.8041	2.02	5.4	5328	127267	0.000	0.001
94	14.50	29.00	2726.00	1.25	24.89	665.8464	2.68	10.1	5328	127267	0.001	0.001
92	14.50	29.00	2668.00	1.24	24.78	662.8385	3.34	16.1	5328	127267	0.001	0.002
90	14.50	29.00	2610.00	1.24	24.67	659.7785	4.00	23.5	5328	127267	0.001	0.002
88	14.50	29.00	2552.00	1.23	24.55	656.6644	4.66	32.1	5328	127267	0.001	0.003
86	14.50	29.00	2494.00	1.23	24.43	653.4939	5.31	42.1	5328	127267	0.001	0.004
84	14.50	29.00	2436.00	1.22	24.31	650.2646	5.96	53.4	5328	127267	0.001	0.005
82	14.50	29.00	2378.00	1.21	24.19	646.9741	6.61	65.9	5734	127267	0.001	0.006
80	14.50	29.00	2320.00	1.21	24.06	643.6195	7.25	79.8	6141	137518	0.001	0.007
78	14.69	29.38	2291.33	1.20	23.94	648.4986	7.90	95.0	6547	147769	0.001	0.008
76	14.88	29.75	2261.15	1.19	23.80	653.2172	8.56	111.4	6954	158021	0.001	0.008
74	15.06	30.13	2229.47	1.19	23.67	657.7691	9.21	129.2	7360	168272	0.001	0.009
72	15.25	30.50	2196.29	1.18	23.54	662.1477	9.88	148.3	7360	178523	0.001	0.010
70	15.44	30.88	2161.60	1.17	23.40	666.3458	10.54	168.7	7360	178523	0.001	0.011
68	15.44	30.88	2099.84	1.17	23.25	662.2917	11.20	190.5	7360	178523	0.002	0.013
66	15.44	30.88	2038.08	1.16	23.11	658.1424	11.86	213.5	7360	178523	0.002	0.014
64	15.44	30.88	1976.32	1.15	22.96	653.8926	12.52	237.9	7360	178523	0.002	0.016
62	15.44	30.88	1914.56	1.14	22.81	649.5366	13.17	263.6	7792	178523	0.002	0.018
60	15.63	31.25	1875.36	1.14	22.65	652.9226	13.82	290.6	8224	189830	0.002	0.018
58	15.82	31.63	1834.66	1.13	22.49	656.0778	14.48	318.9	8656	201137	0.002	0.019
56	16.00	32.01	1792.45	1.12	22.32	658.99	15.13	348.5	9088	212445	0.002	0.020
54	16.19	32.38	1748.74	1.11	22.15	661.646	15.80	379.4	9520	223752	0.002	0.020
52	16.38	32.76	1703.52	1.10	21.98	664.0311	16.46	411.7	9520	235059	0.002	0.021
50	16.38	32.76	1638.00	1.09	21.80	658.5708	17.12	445.2	9520	235059	0.002	0.023
48	16.38	32.76	1572.48	1.08	21.61	652.9352	17.77	480.1	9520	235059	0.002	0.025
46	16.38	32.76	1506.96	1.07	21.42	647.1111	18.42	516.3	9520	235059	0.002	0.026
44	16.38	32.76	1441.44	1.06	21.22	641.0835	19.06	553.8	9520	235059	0.002	0.028
42	16.38	32.76	1375.92	1.05	21.01	634.8356	19.69	592.6	9978	235059	0.002	0.030
40	16.57	33.14	1325.44	1.04	20.80	635.56	20.33	632.6	10435	247516	0.002	0.031
38	16.76	33.51	1273.46	1.03	20.57	635.8681	20.97	673.9	10893	259973	0.002	0.031
36	16.94	33.89	1219.97	1.02	20.34	635.725	21.60	716.4	11350	272431	0.002	0.032
34	17.13	34.26	1164.98	1.01	20.10	635.0901	22.24	760.3	11808	284888	0.002	0.032
32	17.32	34.64	1108.48	1.00	19.84	633.9168	22.87	805.4	11808	297345	0.002	0.033
30	17.32	34.64	1039.20	0.98	19.57	625.362	23.50	851.8	11808	297345	0.002	0.034
28	17.32	34.64	969.92	0.97	19.29	616.3444	24.11	899.4	11808	297345	0.002	0.036
26	17.32	34.64	900.64	0.95	18.99	606.803	24.72	948.2	11808	297345	0.002	0.038
24	17.32	34.64	831.36	0.94	18.68	596.6634	25.32	998.2	11808	297345	0.002	0.040
22	17.32	34.64	762.08	0.92	18.34	585.8331	25.90	1049.4	11808	297345	0.002	0.042
20	17.32	34.64	692.80	0.90	17.97	574.1953	26.48	1101.8	11808	297345	0.002	0.044
18	17.32	34.64	623.52	0.88	17.58	561.5992	27.04	1155.3	11808	297345	0.002	0.047
16	17.32	34.64	554.24	0.86	17.15	547.8448	27.59	1210.0	11808	297345	0.002	0.049
14	17.32	34.64	484.96	0.85	16.92	540.4515	28.13	1265.7	11808	297345	0.002	0.051
12	17.32	34.64	415.68	0.85	16.92	540.4515	28.67	1322.5	11808	297345	0.002	0.053
10	17.32	34.64	346.40	0.85	16.92	540.4515	29.21	1380.3	11808	297345	0.002	0.056
8	17.32	34.64	277.12	0.85	16.92	540.4515	29.75	1439.3	11808	297345	0.003	0.058
6	17.32	34.64	207.84	0.85	16.92	540.4515	30.29	1499.3	11808	297345	0.003	0.061
4	17.32	34.64	138.56	0.85	16.92	540.4515	30.83	1560.4	11808	297345	0.003	0.063
2	17.32	34.64	69.28	0.85	16.92	540.4515	31.37	1622.6	11808	297345	0.003	0.065
0	17.32	34.64	17.32	0.85	16.92	540.4515	31.91	1685.9	11808	297345	0.003	0.068

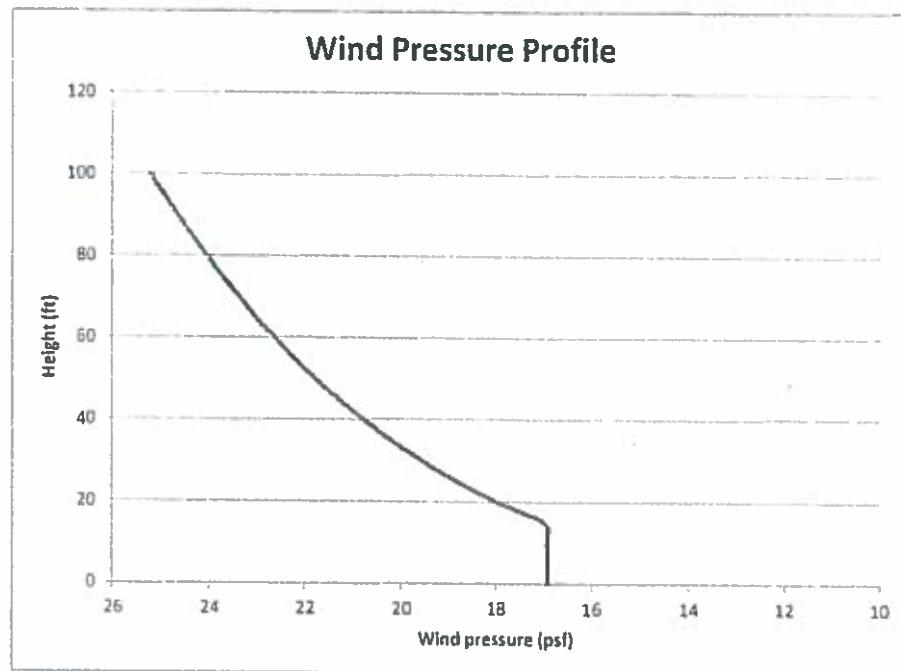
F = 33.70 **Kicks** **F = 36.1554** **(1000000000.000)**

$\Delta = 1541$ fm 3

$$f_{\text{eff}} = 48.8 \text{ Hz}$$

$\beta = -31.61$ ref

$h = 100 \text{ ft}$
 $d = 16.38 \text{ ft}$
 $h/d = 6.1$
 $C_t = 1.09$ (ASCE 7-05 Fig. 6-21)
 $n_1 = 1.623 \text{ Hz}$ (Rigid per ASCE 7-05 6.2)
 $G_t = 0.85$ (ASCE 7-05 6.5.8.1)



frame forces_100ft_45deg

SEISMIC EFFECTS

Ht	A (in^2)	A(ft^2)	Weight	h*W	Σh^*w	Fx (k)	V (k)	M (k-ft)	S (in^3)	Fv (ksi)	Fb (ksi)
100	5328	37.0	4.44	444.0	0.014	2.35	2	0	127267	0.000	0.000
98	5328	37.0	8.88	870.2	0.028	4.61	7	9	127267	0.001	0.001
96	5328	37.0	8.88	852.5	0.027	4.52	11	28	127267	0.002	0.003
94	5328	37.0	8.88	834.7	0.027	4.43	16	55	127267	0.003	0.005
92	5328	37.0	8.88	817.0	0.026	4.33	20	91	127267	0.004	0.009
90	5328	37.0	8.88	799.2	0.025	4.24	24	136	127267	0.005	0.013
88	5328	37.0	8.88	781.4	0.025	4.14	29	189	127267	0.005	0.018
86	5328	37.0	8.88	763.7	0.024	4.05	33	251	127267	0.006	0.024
84	5328	37.0	8.88	745.9	0.024	3.96	37	320	127267	0.007	0.030
82	5328	37.0	8.88	728.2	0.023	3.86	40	397	127267	0.008	0.037
80	5734	39.8	9.56	764.6	0.024	4.05	45	482	137518	0.008	0.042
78	6141	42.6	10.23	798.3	0.025	4.23	49	575	147769	0.008	0.047
76	6547	45.5	10.91	829.3	0.026	4.40	53	677	158021	0.008	0.051
74	6954	48.3	11.59	857.6	0.027	4.55	58	788	168272	0.008	0.056
72	7360	51.1	12.27	883.2	0.028	4.68	62	908	178523	0.008	0.061
70	7360	51.1	12.27	858.7	0.027	4.55	67	1038	178523	0.009	0.070
68	7360	51.1	12.27	834.1	0.027	4.42	71	1176	178523	0.010	0.079
66	7360	51.1	12.27	809.6	0.026	4.29	76	1323	178523	0.010	0.089
64	7360	51.1	12.27	785.1	0.025	4.16	80	1479	178523	0.011	0.099
62	7360	51.1	12.27	760.5	0.024	4.03	84	1642	178523	0.011	0.110
60	7792	54.1	12.99	779.2	0.025	4.13	88	1814	189830	0.011	0.115
58	8224	57.1	13.71	795.0	0.025	4.22	92	1995	201137	0.011	0.119
56	8656	60.1	14.43	807.9	0.026	4.28	97	2183	212445	0.011	0.123
54	9088	63.1	15.15	817.9	0.026	4.34	101	2381	223752	0.011	0.128
52	9520	66.1	15.87	825.1	0.026	4.38	105	2587	235059	0.011	0.132
50	9520	66.1	15.87	793.3	0.025	4.21	109	2801	235059	0.011	0.143
48	9520	66.1	15.87	761.6	0.024	4.04	113	3024	235059	0.012	0.154
46	9520	66.1	15.87	729.9	0.023	3.87	117	3255	235059	0.012	0.166
44	9520	66.1	15.87	698.1	0.022	3.70	121	3493	235059	0.013	0.178
42	9520	66.1	15.87	666.4	0.021	3.53	125	3739	235059	0.013	0.191
40	9978	69.3	16.63	665.2	0.021	3.53	128	3992	247516	0.013	0.194
38	10435	72.5	17.39	660.9	0.021	3.50	132	4251	259973	0.013	0.196
36	10893	75.6	18.15	653.6	0.021	3.47	135	4518	272431	0.012	0.199
34	11350	78.8	18.92	643.2	0.020	3.41	138	4792	284888	0.012	0.202
32	11808	82.0	19.68	629.8	0.020	3.34	142	5072	297345	0.012	0.205
30	11808	82.0	19.68	590.4	0.019	3.13	145	5359	297345	0.012	0.216
28	11808	82.0	19.68	551.0	0.018	2.92	148	5651	297345	0.013	0.228
26	11808	82.0	19.68	511.7	0.016	2.71	151	5950	297345	0.013	0.240
24	11808	82.0	19.68	472.3	0.015	2.50	153	6254	297345	0.013	0.252
22	11808	82.0	19.68	433.0	0.014	2.30	155	6562	297345	0.013	0.265
20	11808	82.0	19.68	393.6	0.013	2.09	157	6875	297345	0.013	0.277
18	11808	82.0	19.68	354.2	0.011	1.88	159	7192	297345	0.013	0.290
16	11808	82.0	19.68	314.9	0.010	1.67	161	7512	297345	0.014	0.303
14	11808	82.0	19.68	275.5	0.009	1.46	162	7836	297345	0.014	0.316
12	11808	82.0	19.68	236.2	0.008	1.25	164	8162	297345	0.014	0.329
10	11808	82.0	19.68	196.8	0.006	1.04	165	8490	297345	0.014	0.343
8	11808	82.0	19.68	157.4	0.005	0.83	166	8821	297345	0.014	0.356
6	11808	82.0	19.68	118.1	0.004	0.63	166	9153	297345	0.014	0.369
4	11808	82.0	19.68	78.7	0.003	0.42	167	9486	297345	0.014	0.383
2	11808	82.0	19.68	39.4	0.001	0.21	167	9819	297345	0.014	0.396
0	11808	82.0	9.84	4.92	0.000	0.03	167	10153	297345	0.014	0.410

747.53 31472.9 167

CoG = 42.1 ft

ap = 2.5

Rp = 2.5

Ip = 1.0

h = 100.0 ft

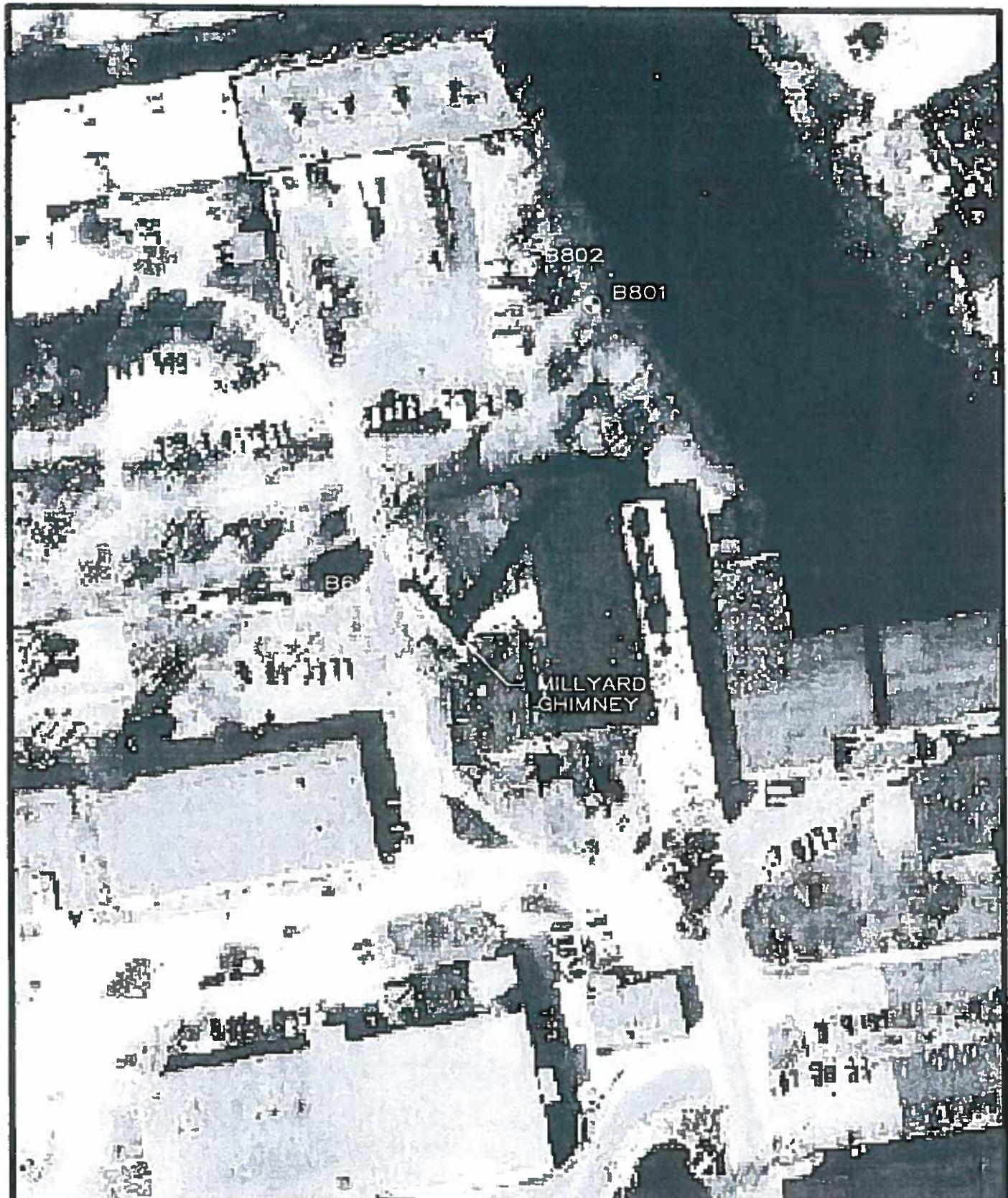
(ASCE 41-06 Table 11-2)

frame forces_100ft_45deg

ULTIMATE STRESS

Height	WIND						SEISMIC					
	1.0°fa	1.0°fv	1.0°fb	Fv	Fr*	Fc*	0.9°fa	1.0°fv	1.0°fb	Fv	Fr*	Fc*
100	0.001	0.000	0.000	0.000	-0.001	-0.001	0.001	0.000	0.000	0.000	-0.001	-0.001
98	0.003	0.000	0.000	0.000	-0.002	-0.003	0.002	0.001	0.001	0.001	-0.001	-0.003
96	0.004	0.000	0.001	0.000	-0.004	-0.005	0.004	0.002	0.002	0.003	0.002	-0.001
94	0.006	0.001	0.001	0.001	-0.005	-0.007	0.005	0.003	0.005	0.003	0.000	-0.006
92	0.008	0.001	0.002	0.001	-0.006	-0.009	0.007	0.004	0.004	0.009	0.004	0.000
90	0.009	0.001	0.002	0.001	-0.007	-0.011	0.008	0.005	0.005	0.013	0.005	0.002
88	0.011	0.001	0.003	0.001	-0.008	-0.014	0.010	0.005	0.018	0.005	0.005	-0.021
86	0.013	0.001	0.004	0.001	-0.009	-0.016	0.011	0.006	0.024	0.006	0.012	-0.028
84	0.014	0.001	0.005	0.001	-0.009	-0.019	0.013	0.007	0.030	0.007	0.017	-0.035
82	0.015	0.001	0.006	0.001	-0.010	-0.022	0.014	0.008	0.037	0.008	0.023	-0.043
80	0.016	0.001	0.007	0.001	-0.009	-0.023	0.015	0.008	0.042	0.008	0.027	-0.052
78	0.017	0.001	0.008	0.001	-0.009	-0.025	0.015	0.008	0.047	0.008	0.031	-0.062
76	0.018	0.001	0.008	0.001	-0.009	-0.026	0.016	0.008	0.051	0.008	0.036	-0.067
74	0.018	0.001	0.009	0.001	-0.009	-0.027	0.016	0.008	0.056	0.008	0.040	-0.073
72	0.019	0.001	0.010	0.001	-0.009	-0.029	0.017	0.008	0.061	0.008	0.044	-0.078
70	0.021	0.001	0.011	0.001	-0.009	-0.032	0.018	0.009	0.070	0.009	0.051	-0.088
68	0.022	0.002	0.013	0.002	-0.009	-0.035	0.020	0.010	0.079	0.010	0.059	-0.099
66	0.024	0.002	0.014	0.002	-0.010	-0.038	0.021	0.010	0.089	0.010	0.067	-0.110
64	0.026	0.002	0.016	0.002	-0.010	-0.042	0.023	0.011	0.099	0.011	0.076	-0.122
62	0.027	0.002	0.018	0.002	-0.009	-0.045	0.024	0.011	0.110	0.011	0.086	-0.135
60	0.027	0.002	0.018	0.002	-0.009	-0.046	0.025	0.011	0.115	0.011	0.090	-0.139
58	0.028	0.002	0.019	0.002	-0.009	-0.047	0.025	0.011	0.119	0.011	0.094	-0.144
56	0.028	0.002	0.020	0.002	-0.008	-0.048	0.025	0.011	0.123	0.011	0.098	-0.148
54	0.028	0.002	0.020	0.002	-0.008	-0.049	0.025	0.011	0.128	0.011	0.102	-0.153
52	0.029	0.002	0.021	0.002	-0.008	-0.050	0.026	0.011	0.132	0.011	0.106	-0.158
50	0.030	0.002	0.023	0.002	-0.008	-0.053	0.027	0.011	0.143	0.011	0.116	-0.170
48	0.032	0.002	0.025	0.002	-0.007	-0.056	0.029	0.012	0.154	0.012	0.126	-0.183
46	0.034	0.002	0.026	0.002	-0.007	-0.060	0.030	0.012	0.166	0.012	0.136	-0.196
44	0.035	0.002	0.028	0.002	-0.007	-0.064	0.032	0.013	0.178	0.013	0.147	-0.210
42	0.037	0.002	0.030	0.002	-0.007	-0.067	0.033	0.013	0.191	0.013	0.158	-0.224
40	0.037	0.002	0.031	0.002	-0.006	-0.068	0.033	0.013	0.194	0.013	0.160	-0.227
38	0.037	0.002	0.031	0.002	-0.006	-0.068	0.033	0.013	0.196	0.013	0.163	-0.230
36	0.037	0.002	0.032	0.002	-0.006	-0.069	0.033	0.012	0.199	0.012	0.166	-0.232
34	0.037	0.002	0.032	0.002	-0.005	-0.069	0.034	0.012	0.202	0.012	0.168	-0.235
32	0.037	0.002	0.033	0.002	-0.005	-0.070	0.034	0.012	0.205	0.012	0.171	-0.238
30	0.039	0.002	0.034	0.002	-0.005	-0.074	0.035	0.012	0.216	0.012	0.181	-0.251
28	0.041	0.002	0.036	0.002	-0.005	-0.077	0.037	0.013	0.228	0.013	0.191	-0.265
26	0.042	0.002	0.038	0.002	-0.004	-0.081	0.038	0.013	0.240	0.013	0.202	-0.278
24	0.044	0.002	0.040	0.002	-0.004	-0.084	0.040	0.013	0.252	0.013	0.213	-0.292
22	0.046	0.002	0.042	0.002	-0.003	-0.088	0.041	0.013	0.265	0.013	0.224	-0.306
20	0.047	0.002	0.044	0.002	-0.003	-0.092	0.043	0.013	0.277	0.013	0.235	-0.320
18	0.049	0.002	0.047	0.002	-0.003	-0.096	0.044	0.013	0.290	0.013	0.246	-0.334
16	0.051	0.002	0.049	0.002	-0.002	-0.100	0.046	0.014	0.303	0.014	0.257	-0.349
14	0.052	0.002	0.051	0.002	-0.001	-0.104	0.047	0.014	0.316	0.014	0.269	-0.363
12	0.054	0.002	0.053	0.002	-0.001	-0.108	0.049	0.014	0.329	0.014	0.281	-0.378
10	0.056	0.002	0.056	0.002	0.000	-0.112	0.050	0.014	0.343	0.014	0.292	-0.393
8	0.057	0.003	0.058	0.003	0.001	-0.116	0.052	0.014	0.356	0.014	0.304	-0.408
6	0.059	0.003	0.061	0.003	0.001	-0.120	0.053	0.014	0.369	0.014	0.316	-0.423
4	0.061	0.003	0.063	0.003	0.002	-0.124	0.055	0.014	0.383	0.014	0.328	-0.438
2	0.062	0.003	0.065	0.003	0.003	-0.128	0.056	0.014	0.396	0.014	0.340	-0.452
0	0.063	0.003	0.068	0.003	0.005	-0.131	0.057	0.014	0.410	0.014	0.353	-0.467

*Positive values indicate tension and negative values indicate compression.



100

0

100

200

300

400 FEET

SCALE: 1"=100 Feet

BORING LOCATION	560+96, L1 23'			DATE START - FINISH	10/22/98 - 10/26/98	B801		
GROUND ELEVATION	150.8	DATUM	NGVD	DRILLED BY	Maine Test Boring			
GROUND WATER EL.	DATE			LOGGED BY	Brian F. Jankauskas			
				TOTAL DEPTH	(FT) 60.5			
				Page 1 of 3				
DEPTH FT.	SAMPLE			SOIL AND ROCK DESCRIPTIONS	FIELD TESTS	STRATUM DESCRIPT.	Remarks	
	TYPE AND NO.	BLOWS /IN. H	PEN IN.	REC IN.				
	S1	1-2 2-8	2	0.6	Top 0.2'- TOPSOIL Bottom 0.4'- SAND (SP) Narrowly graded. Mostly fine sand, 5% Non-plastic fines some roots, brown, FILL	0.2'		
5	S2	3-2 2-1	2	0.6	SAND (SP) Narrowly graded. Mostly fine to medium sand, ~20% brick/cinders, 5% Non-plastic fines, brown, FILL		FILL	
10	S3	3-2 1-2	2	0.4	CINDERS/SLAG WITH SAND Mostly cinders and slag, ~40% medium sand, black, FILL			
15	S4	1-1 3-4	2	0.4	SAND (SP) Narrowly graded. Mostly fine sand, ~5% cinders, 5% rounded fine gravel, 5% Non-plastic fines, dark brown	17'		
20	S5	4-3 4-3	2	0.6	SAND (SP) Narrowly graded. Mostly fine sand, <5% Non-plastic fines, brown		SAND AND SILTY SAND	
25	S6	4-5 6-5	2	0.5	SAND (SP) Narrowly graded. Mostly fine to medium sand, <5% Non-plastic fines, brown			
30								

BLOWS PER 6 IN. - 140 LB. HAMMER FALLING 30 IN. TO DRIVE A
 12.0 IN. OD SPLIT SPOON SAMPLER
 NOR-WEIGHT OF RODS
 NOH-WEIGHT OF RODS AND HAMMER
 PEN-PENETRATION LENGTH OF SAMPLER OR CORE BARREL
 REC-LENGTH OF RECOVERED SAMPLE
 QD-LENGTH OF SOUND CORE SECTIONS > 4 IN./LENGTH CORED, %
 -SPLIT SPOON SAMPLE Sv-TORVANE Qd-PENETROMETER
 -UNDISTURBED SAMPLE V GROUND WATER

Notes: Case (drive) wash boring

Broad Street Parkway

© GEI Consultants, Inc.
 Project 98217

BORING LOCATION 560+96, Lt 23'					DATE START - FINISH 10/22/98 - 10/26/98			B801
GROUND ELEVATION 150.8 DATUM NGVD					DRILLED BY Maine Test Boring			
GROUND WATER EL. DATE					LOGGED BY Brian F. Jankauskas	TOTAL DEPTH (FT)	60.5	
DEPTH FT.	SAMPLE				SOIL AND ROCK DESCRIPTIONS	FIELD TESTS	STRATUM DESCRIPT.	Remarks
	TYPE ENO	BLOWS 14 IN	PEN R	REC T				
30	S7	9-13 11-11	2	0.6	SAND (SP) Narrowly graded. Mostly fine to medium sand, <5% non-plastic, brown			
35	S8	10-10 10-12	2	1.0	SILTY SAND (SM) Narrowly graded. Mostly fine sand, 15% non-plastic fines, brown		SAND AND SILTY SAND	
40	S9	14-13 14-17	2	0.6	SAND (SW) Widely graded. Mostly fine to coarse sand, 10% sub-rounded fine gravel, <5% non-plastic fines, brown			
45	S10	6-4 5-7	2	0.3	SAND (SP) Narrowly graded. Mostly fine to medium sand, <5% non-plastic fines, brown	47'		
50	S11	33-26 20-24	2	0.6	SAND WITH GRAVEL (SP) Narrowly graded. Mostly fine to medium sand, 35% angular fine gravel, 5% non-plastic fines, top 0.2' rusty brown, bottom 0.4' gray/brown		SAND WITH GRAVEL	
55	S12	23-19 18-11	2	0.9	SILTY SAND (SM) Narrowly graded. Mostly fine sand, -20% non-plastic fines, 5% rounded gravel, brown	55'		SILTY SAND
60						60'		Casing refusal at 60'
BLOWS PER 6 IN. - 140 LB. HAMMER FALLING 30 IN. TO DRIVE A 2.0 IN. OD SPLIT SPOON SAMPLER					Notes:			
WOW-WEIGHT OF RODS								
WOH-WEIGHT OF RODS AND HAMMER								
PEN-PENETRATION LENGTH OF SAMPLER OR CORE BARREL								
REC-LENGTH OF RECOVERED SAMPLE								
RQD-LENGTH OF SOUND CORE SECTIONS > 4 IN./LENGTH CORED, %								
S-SPLIT SPOON SAMPLE		Sv-TORVANE	Op-PENETROMETER			Broad Street Parkway		
U-UNDISTURBED SAMPLE		V GROUND WATER				© GEI Consultants, Inc. Project 98217		

BORING LOCATION	560+96. LT. 23'	DATE START - FINISH	10/22/98 - 10/26/98	B801	
GROUND ELEVATION	150.8	DATUM	NGVD		
GROUND WATER EL.	DATE	DRILLED BY	Maine Test Boring		
		LOGGED BY	Brian F. Jankauskas	TOTAL DEPTH	
				(FT) 60.5	
DEPTH	SAMPLE	SOIL AND ROCK DESCRIPTIONS	FIELD TESTS	STRATUM DESCRIPT.	
FT	TYPE SNO	BLOWS IN	PEN	REC H	Remarks
60		Roller bit from 60' to 60.5' Cobble or Possible Bedrock 60.5' Bottom of Boring 60.5'		P-BEDROCK	
65					
70					
75					
80					
85					
90					
BLOWS PER 6 IN. - 140 LB. HAMMER FALLING 30 IN. TO DRIVE A 2.0 IN. OD SPLIT SPOON SAMPLER			Notes:		
WOW-WEIGHT OF RODS					
WOH-WEIGHT OF RODS AND HAMMER					
PEN-PENETRATION LENGTH OF SAMPLER OR CORE BARREL					
REC-LENGTH OF RECOVERED SAMPLE					
RQD-LENGTH OF SOUND CORE SECTIONS > 4 IN./LENGTH CORED, %					
S-SPLIT SPOON SAMPLE	Sv-TORVANE	Op-PENETROMETER	Broad Street Parkway		
U-UNDISTURBED SAMPLE	V-GROUND WATER		Φ GEI Consultants, Inc. Project 98217		

BORING LOCATION 560+94; RL 33'
 GROUND ELEVATION 151.2 DATUM NGVD
 GROUND WATER EL. DATE

DATE START - FINISH 10/21/98- 10/22/98
 DRILLED BY Maine Test Boring
 LOGGED BY Brian F. Jankauskas

TOTAL DEPTH (FT) 73.0

B802

Page 1 of 3

DEPTH FT.	SAMPLE				SOIL AND ROCK DESCRIPTIONS	FIELD TESTS	STRATUM DESCRIPT.	Remarks
	TYPE & NO.	BLOWS /IN	PEN R	REC R				
0	S1	1-2 3-10	2	1.2	UPPER 0.7'-TOPSOIL MIDDLE 0.3'- SAND (SP) Narrowly graded. Mostly fine sand, 5% Non-plastic fines, -10% ash, FILL. BOTTOM 0.2'- SAND (SP) Narrowly graded. mostly fine sand, 5% non-plastic fines, brown.	1.0' 1.5'	TOPSOIL FILL	
5	S2	5-3 3-2	2	0.4	SILTY SAND (SM) Narrowly graded. Mostly fine sand, ~40% non-plastic fines, brown with dark brown stratification.			
10	S3	3-2 3-3	2	0.5	SAND (SP) Narrowly graded. Mostly fine to medium sand, <5% non-plastic fines, brown.			
15	S4	6-8 8-7	2	0.5	SAND (SP) Narrowly graded. Mostly fine sand, 5% non-plastic fines, brown.		SAND AND SILTY SAND	
20	S5	15-10 9-11	2	0.4	SIMILAR TO S4, 10% fine gravel.			
25	S6	11-14 19-18	2	0.6	SIMILAR TO S4.			
30								

BLOWS PER 6 IN. - 140 LB. HAMMER FALLING 30 IN. TO DRIVE A 2.0 IN. OD SPLIT SPOON SAMPLER
 WOH-WEIGHT OF RODS
 WOH-WEIGHT OF RODS AND HAMMER
 PEN-PENETRATION LENGTH OF SAMPLER OR CORE BARREL
 REC-LENGTH OF RECOVERED SAMPLE
 RQD-LENGTH OF SOUND CORE SECTIONS > 4 IN./LENGTH CORED, %
 S-SPLIT SPOON SAMPLE Sv-TORVANE Op-PENETROMETER
 U-UNDISTURBED SAMPLE V GROUND WATER

Notes: Cased (driven) wash boring

Broad Street Parkway

Φ GEI Consultants, Inc.
 Project 98217

BORING LOCATION	560+94; RI 33'			DATE START - FINISH	10/21/98 - 10/22/98	TOTAL DEPTH (FT.)	B802
GROUND ELEVATION	151.2 DATUM NGVD			DRILLED BY	Maine Test Boring		
GROUND WATER EL.	DATE			LOGGED BY	Brian F. Jankauskas	73.0	Page 3 of 3
DEPTH FT.	SAMPLE			SOIL AND ROCK DESCRIPTIONS	FIELD TESTS	STRATUM DESCRIP.	Remarks
	TYPE NO.	BLOWS /6 IN	PEN IN	REC %			
60	S13	32-76 100- 111/ 0.3	1.8	1.1	SILTY SAND WITH GRAVEL (SP) Mostly fine sand, 15% non-plastic fines, 15% fine angular gravel, brown. 61.8'	GLACIAL TILL	
63.0	R2	3 min 3 min 2 min 4 min	4.0	3.4	GRANITE Fractures spaced from 1" to 3" apart, dipping at 40, 50, 70, and 80 degrees from the horizontal. Upper 1.5' is slightly weathered with discoloration and multiple fractures. Lower 1.9' is unweathered. RQD = 8%.		
65	R3	4 min 3 min 3 min 4 min 2 min/0.2	4.2	4.1	GRANITE Fractures spaced from about 1" to 7" apart, dipping at 20, 30, 40, 50, 60 and 70 degrees from the horizontal. Slightly weathered. RQD = 42%.		BEDROCK
70	R4	3 min 2 min/0.8	1.8	1.7	GRANITE Fractures spaced from 1" to 7" apart, dipping at 0, 40, 60, 70 and 90 degrees from the horizontal. Near vertical 15" long fracture. Slightly weathered. RQD=64%.	73.0'	
					Bottom of Boring 73.0'		
75							
80							
85							
90							
BLOWS PER 6 IN. - 140 LB. HAMMER FALLING 30 IN. TO DRIVE A 2.0 IN. OD SPLIT SPOON SAMPLER					Notes:		
WOR-WEIGHT OF RODS							
WOH-WEIGHT OF RODS AND HAMMER							
PEN-PENETRATION LENGTH OF SAMPLER OR CORE BARREL							
REC-LENGTH OF RECOVERED SAMPLE							
ROD-LENGTH OF SOUND CORE SECTIONS > 4 IN / LENGTH CORED, %							
S-SPLIT SPOON SAMPLE		Sv-TORVANE	Qp-PENETROMETER			φ GEI Consultants, Inc.	
U-UNDISTURBED SAMPLE		V GROUND WATER				Project 98217	
Broad Street Parkway							



GEI Consultants, Inc.

TEST BORING LOG

PROJECT: Broad Street Parkway
 NUMBER: 98217
 LOCATION: Nashua, NH

PAGE 1 OF 1
 BORING NUMBER B64

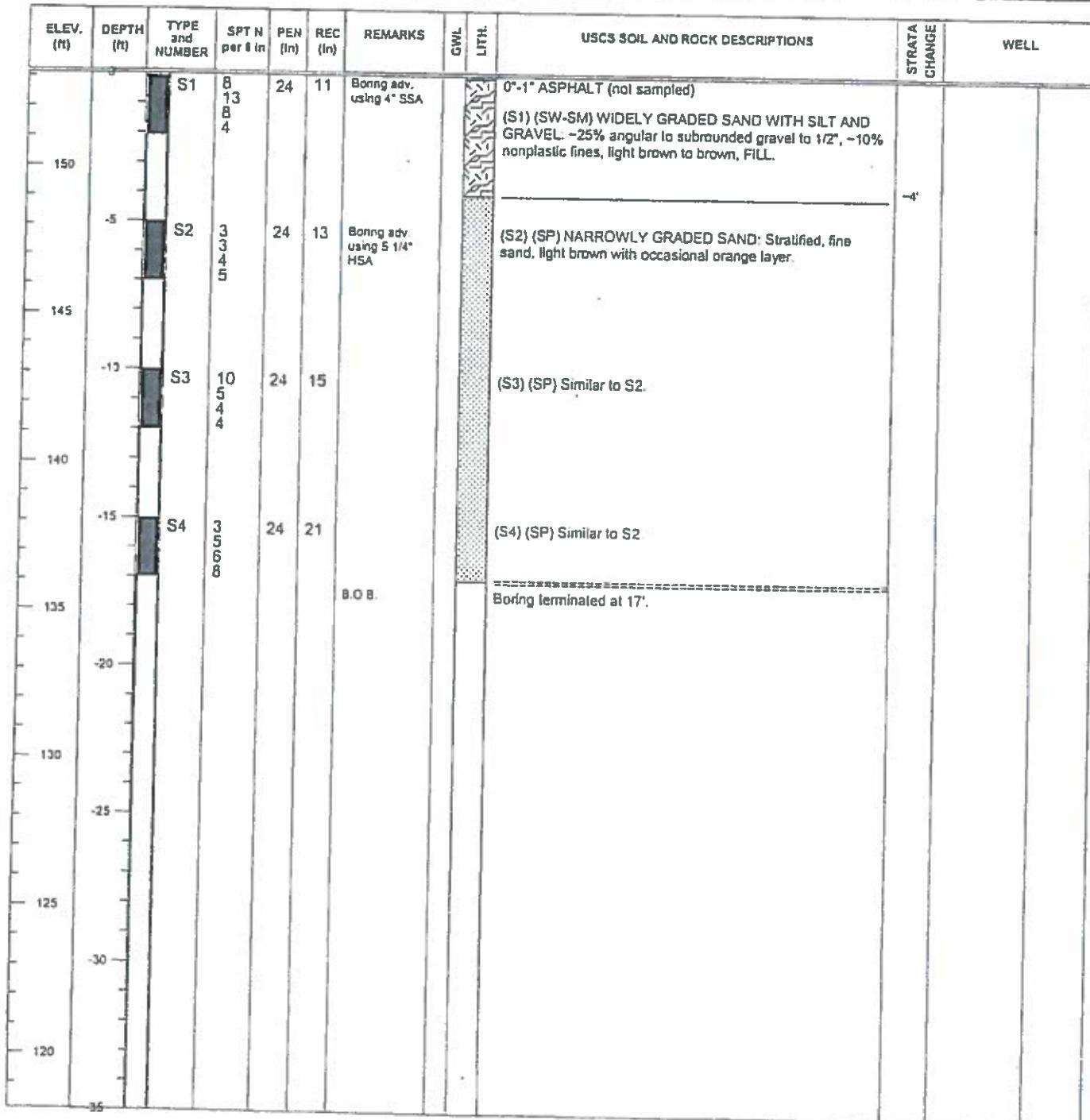
BORING LOCATION: Sta 863+97.8E
 GROUND ELEV. (NGVD): 153.1'
 START / FINISH DATE: 02/27/01
 GW DEPTH / ELEV.: Not Encountered
 GW DATE / TIME: Not Encountered

TOTAL DEPTH: 17'
 SOIL BORING: 17'
 ROCK CORE: 0'
 DRILLED BY: MTB
 LOGGED BY: ALS

BLOWS PER 6 IN. - 140 LB. HAMMER FALLING 30 IN. TO DRIVE A 2.0 IN O.D. SPLIT SPOON SAMPLER
 NM - NOT MEASURED
 PEN - PENETRATION LENGTH OF SAMPLER OR CORE BARREL
 REC - RECOVERY LENGTH OF SAMPLE
 ROD - LENGTH OF SOUND CORES > 4 IN / LENGTH CORED, (%)
 S - SPLIT SPOON SAMPLE
 A - AUGER SAMPLE
 U - UNDISTURBED SAMPLE
 UF - UNDISTURBED SAMPLE, FIXED PISTON
 UO - UNDISTURBED SAMPLE, OSTERBERG

- MEASURED GWL
 - ESTIMATED GWL

NOTES:





May 17, 2010

Public Works Division
City of Nashua
9 Riverside Drive
Nashua, NH 03062-1373

Attn: Leon Kennison, Director

Sub: Chimney Inspection
Site: 10 Technology Way
Nashua, NH 03062

On May 3, 2010 our workmen performed an exterior inspection of the common brick chimney in accordance with our Proposal dated February 2, 2010. The following is a report of our findings, recommendations, and estimated cost for repairs. Photographs of the inspection are enclosed for your information.

FINDINGS

Construction	Common Brick
Height	180'
Outside Diameter	10' 3" x 10' 3" @ top, 18' 3" @ base
Inside Diameter	8' 4" @ top
Cap	Reinforced concrete
Lightning Protection	4 - 6' copper points, One circuit cable. Two downleads

INTERIOR

- ♦ Due to the unsafe condition of the interior lining, our workmen were unable to perform a complete interior inspection. (see photographs)
- ♦ The upper section of the interior lining that was rebuilt with radial brick is in poor structural condition.

EXTERIOR NORTH

- ◆ The concrete cap is in fair condition.
- ◆ The lightning protection downlead is disconnected 6' up from grade.
- ◆ There is bulging and loose brickwork throughout the top 20' of the chimney.
- ◆ The brickwork below the top 20' has numerous open and deteriorated mortar joints down to grade level.

EXTERIOR SOUTH

- ◆ The concrete cap is in fair condition.
- ◆ The brickwork throughout the top 20' is in poor condition.
- ◆ The lightning protection equipment is weathered.
- ◆ The lettering on this side of the chimney is weathered
- ◆ There are numerous open joints, fractures, and deteriorated mortar joints down to the roof level.

EXTERIOR EAST

- ◆ The concrete cap is in fair condition.
- ◆ The brickwork throughout the top 20' is in poor condition.
- ◆ The lettering on this side of the chimney is weathered.
- ◆ The remaining brickwork down to the roof level has numerous open and deteriorated mortar joints.

EXTERIOR WEST

- ◆ The concrete cap is in fair condition.
- ◆ The brickwork throughout the top 20' is in poor condition.
- ◆ The remaining brickwork down to grade has numerous open and deteriorated mortar joints.

RECOMMENDATIONS

- ◆ Remove and rebuild the top 20' of the chimney.
- ◆ Remove the interior lining down to a stable level.
- ◆ Uniform cut-out and tuck-point the entire exterior surface of the chimney
- ◆ Remove and replace the lightning protection system in accordance with NFPA specifications for lightning protection to high-rise industrial chimneys.
- ◆ Install a reinforced monolithic concrete cover to seal the top of the chimney from the weather.
- ◆ Remove all brick and soot accumulation at the interior base of the chimney.
- ◆ Restore the chimney lettering on the East and South elevations.
- ◆ Waterblast clean the entire exterior chimney surface upon completion of the masonry repairs.
- ◆ Waterproof the entire exterior surface of the chimney.
- ◆ Provide a ventilation system to allow air circulation through the chimney.

The estimated cost to repair the chimney in accordance with our recommendations is:

FOUR HUNDRED EIGHTY-EIGHT THOUSAND SEVEN HUNDRED FIFTY DOLLARS (\$488,750.00)

***NOTE:** It is my opinion from more than fifty years of experience in the industrial chimney business that the bottom 160' of the Millary chimney is in good structural condition.

Thank you for the opportunity to be of service to the City of Nashua. Should you have any questions, please do not hesitate to contact me.

Sincerely,

Boston Chimney & Tower Co., LLC

Ronald G. Plante
Ronald G. Plante
RGP/mpt

Enc: Photographs

Wheelock, Peter

From: Dumont, Roger W. <RWD@internationalchimney.com>
Sent: Friday, April 15, 2011 2:47 PM
To: Wheelock, Peter
Cc: Scott Pollock
Subject: RE: Nashua Chimney

Peter,

Richard has taken the wall thickness measurements and they are as follows
Chimney height from grade 162' as it currently stands. Grade was taken from street side

162' - 12"
152' - 12"
142' - 12"
132' - 12"
122' - 12"
112' - 12"
92' - 12"
82' - 12"
72' - 16"
62' - 16"
52' - 20"
42' - 20"
32' - 24"
22' - 24"
12' - 24"
4' - 24"

Roger W. Dumont
International Chimney Corporation
55 South Long Street - P.O Box 260
Buffalo, New York 14221
RWD@internationalchimney.com
Office - 860/779-2380 Mobile - 860/778-5237 Fax - 860/774-4124

From: Wheelock, Peter [mailto:pwheelock@wai.com]
Sent: Thu 4/14/2011 9:00 AM
To: KenisonL@nashuanh.gov
Cc: JVancor@hayner-swanson.com; Dumont, Roger W.
Subject: Nashua Chimney

Mr. Kenison,

I received a call from Mr. Dumont, International Chimney today and he said that they were in the process of taking the wall thickness measurement. Unfortunately, I am unavailable to rush up there, but Mr. Dumont assured me that they are used to taking wall measurements and it will not be a problem for us. They will be starting to point the top five feet of the chimney with type N mortar

and they will temporarily cap the top and be finished in three days. Roger mentioned that the wall 15ft from the top is still 12 inches and three wythes thick.

Roger, Please send us preliminary information about the wall thicknesses before you close up shop. Also, please provide us with the plan dimension at the elevation where you stopped.

Thank you,

Peter

Peter Wheelock, Associate
Weidlinger® Associates Inc.
201 Broadway, 4th Floor
Cambridge, MA, 02139

Tel. (617) 374-0000

Fax (617) 374-0010

Mail to: pwheelock@ma.wai.com

<http://www.wai.com>

Weidlinger Associates, Inc. made the following annotations.

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"Please consider our environment before printing this email."